ENGINEERING NEWS-RECORD

DECEMBER 13, 1945

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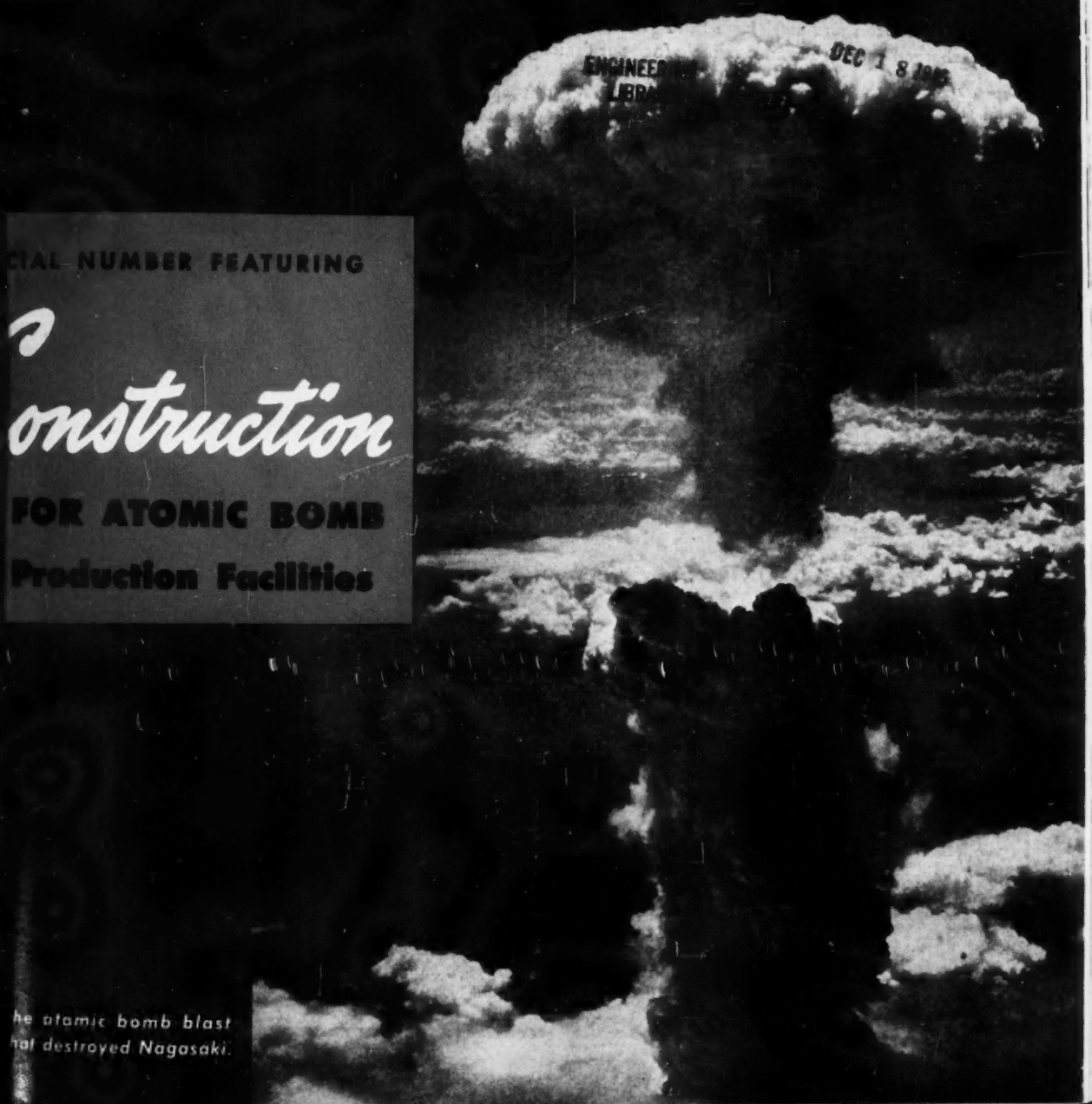

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he atomic bomb blast
hat destroyed Nagasaki.

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With the war ended in Europe, Asia, and the Pacific, iron and steel have been "honorably discharged" and are again available for your drainage and other needs. During the days of material restrictions and substitutes you will recall how ARMCO Emergency Wood Pipe served a useful purpose. It was another unusual Armco service. But steel, so indispensable for ships, guns, equipment, landing mats, and for portable culverts in the forward areas, is also indispensable for peacetime construction.

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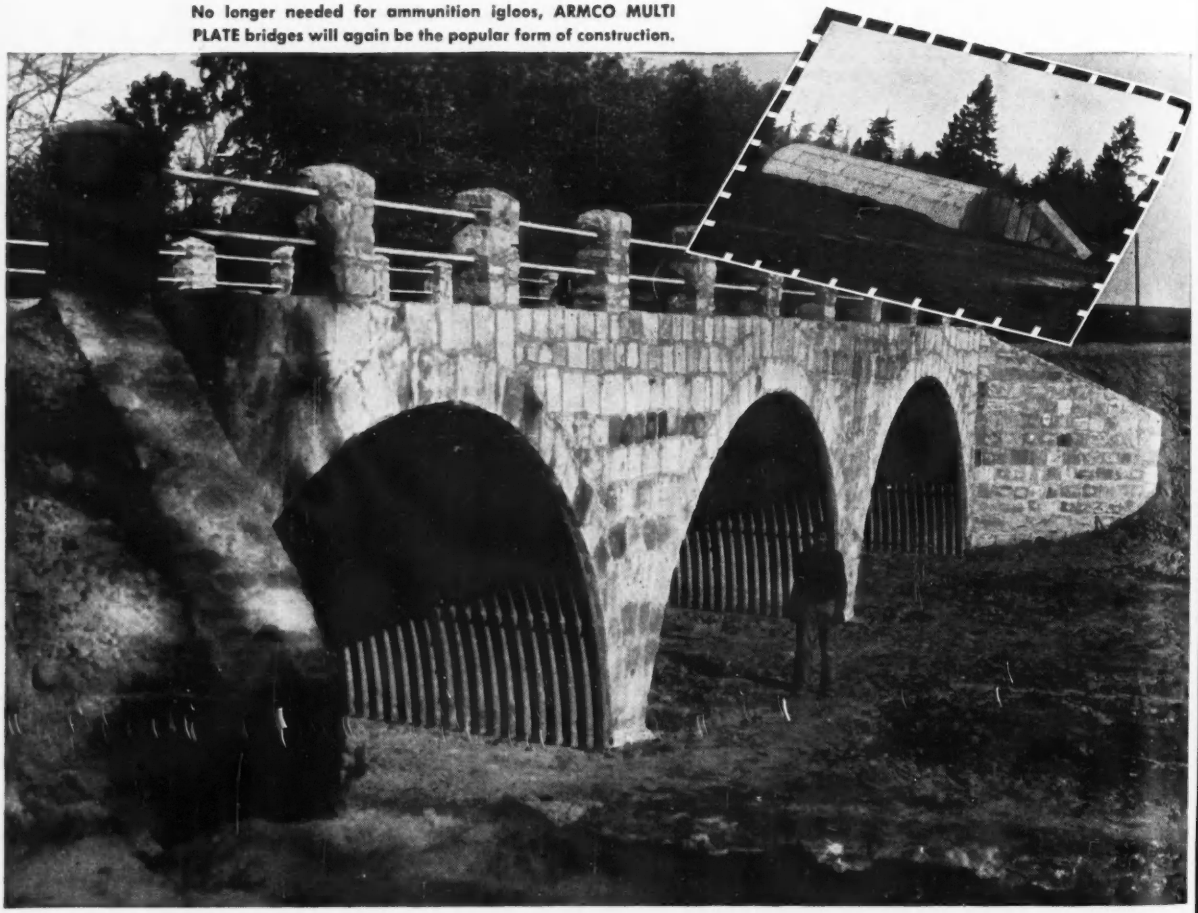
No longer needed for ammunition igloos, ARMCO MULTI PLATE bridges will again be the popular form of construction.



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WALDO G. BOWMAN, *Editor* ALBERT E. PAXTON, *Manager*

Vol. 135 DECEMBER 13, 1945 No. 24

COMING NEXT

• Construction of underground oil storage vaults at Pearl Harbor involved many features for which no precedent was found in design or construction procedure. The vaults are concrete-lined vertical cylinders 100 ft. in dia. and 250 ft. high overall with dome-shaped ends at top and bottom. Excavation for each vault is lined with concrete and faced on the inside with steel. Prestress in the concrete was applied by pressure grouting between lining and rock. The project will be described in the Dec. 27 issue.

• The longest construction cableways ever built were required at Norfork Dam for placing 1,500,000 cu. yd. of concrete. The essential features of design, erection, mechanical operation and control will be outlined in the Dec. 27 issue. A major failure of one of the cables was experienced. A description of the failure and a diagnosis of the cause will be given.

• The Hawkesbury River in New South Wales, Australia, long known for its deep, soft-mud bottom and consequent foundation-building difficulties, has again been spanned—this time by a bridge in which one pier is more than 240 ft. deep. The two main spans are entirely shop welded trusses of 438-ft. length, said to be the longest trusses in the world built by this method. Foundation problems and construction procedure will be described in *ENR* Dec. 27.

LOOKING AHEAD

• The 650-mile long, 9-ft. deep navigation channel on the Tennessee River from the Ohio to Knoxville is now virtually complete. It is estimated that by 1960 savings in transportation costs will amount to $2,000,000 per year more than depreciation of structures, cost of maintenance and interest on the investment allocated to navigation facilities. Two articles on this project are scheduled for early publication—"Current Trends in River Commerce" and "Channel Improvements and Shipping Facilities".

Annual
HIGHWAY NUMBER
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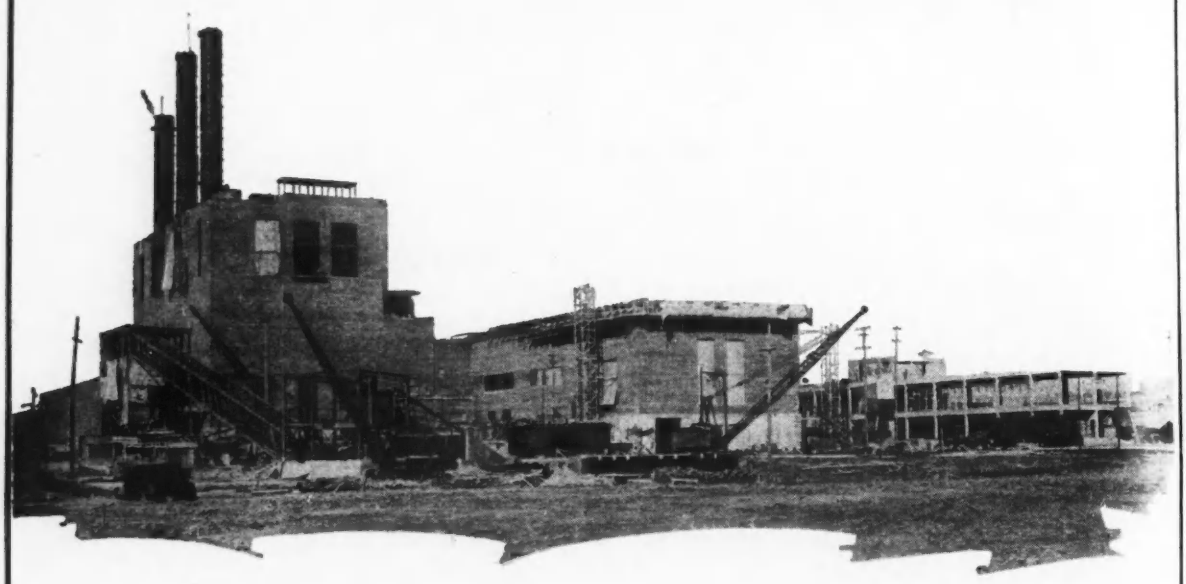

We are gratified to have been able to cooperate with the U. S. Army in part of the construction of the Clinton Engineering Works.

The overcoming of the difficulties in the construction of the foundations for this power plant is another example of accomplishment by the experienced organization of THE FOUNDATION COMPANY.

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New Construction in November

Civil Engineering construction volume climbed to $315,709,000 in November, with an average of $63,140,000 for each of the five weeks of the month. November volume is the highest since April 1943. Private construction continued to climb and reached a fifteen year high of $232,067,000. The November weekly average is 5 percent greater than last month and 143 percent greater than November 1944.

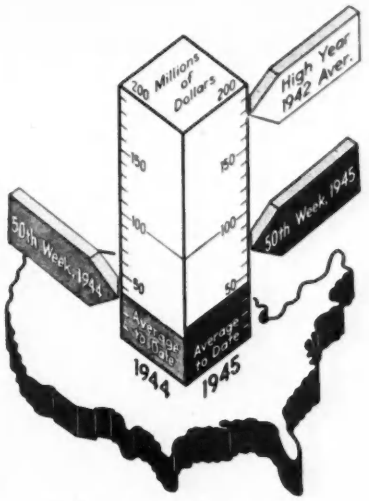
Private construction, on the weekly average basis, tops last month by 4 percent and last year by 575 percent, due to greatly increased activity in commercial and industrial building. Public construction volume for the month is 37 percent greater than last month, but is 12 percent below the month last year. State and Municipal is 14 percent over last month and 205 percent over November 1944. Federal work, while 88 percent greater than last month, is 56 percent below the corresponding month of 1944.

The November construction total brings the 1945 cumulative figure for the eleven months to $2,051,399,000, a 25 percent increase over the $1,636,496,000 reported for the eleven-month period of 1944. Private construction cumulative volume is now $972,014,000, a 179 percent increase over the $348,221,000 total for the same period last year. State and municipal construction total for eleven months is $350,062,000 or 52 percent greater than the period last year. Public and federal construction totals are 16 percent and 31 percent, respectively, below the totals for the same period of 1944.

Industrial building with an eleven-month volume total of $545,746,000, tops all of the war year totals for a like period and is 229 percent greater than the total for the same period last year.

Breaking down the country's cumulative eleven-month total geographically, all but one region records gain over the same period of 1944. The Far Western states while having a total higher than any of the other five sections ($476,665,000), is 15 percent below the total for last year. Other regions recorded gains as follows: New England, 77 percent; Middle Atlantic, 58 percent; Southern, 7 percent; Middle West, 95 percent; West of the Mississippi, 36 percent.

(*See Volume Table, Page* 101)

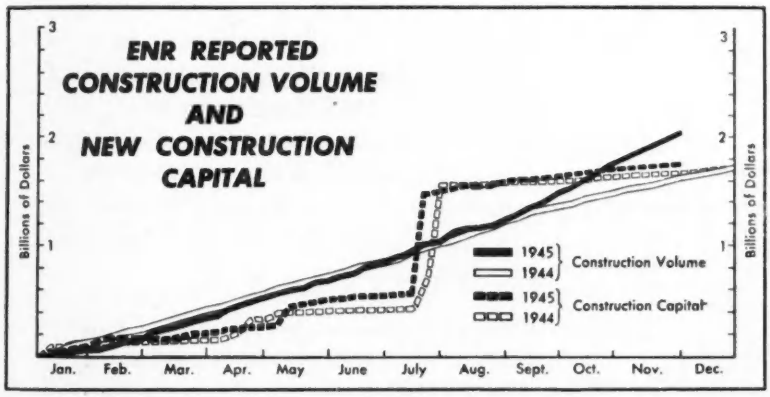


As Reported This Week to...
Engineering News-Record

CONTRACT VOLUME

Continental U. S. Only
(Thousands of Dollars)

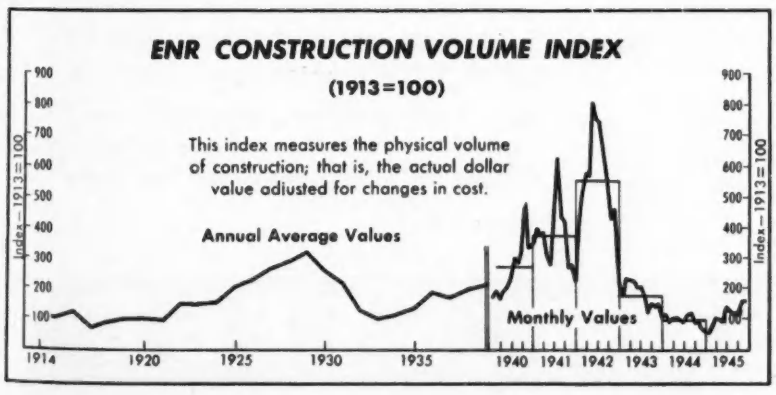
	Week of Dec. 13 1945	Cumulative 1945 (50 wk.)	Cumulative 1944 (50 wk.)
Federal	$9,190	$742,456	$1,096,283
State & Mun.	10,053	381,669	236,394
Total Public.	19,243	1,124,125	1,332,677
Total Private	48,399	1,075,257	353,701
U. S. Total	$67,642	$2,199,382	$1,686,378



WHERE CONSTRUCTION ACTIVITY ORIGINATED THIS WEEK

Type of Work	Dollar Volume (Thousands) This Week	Cumulative 1945 (50 wk.)	Cumulative 1944 (50 wk.)
Waterworks	$534	$60,048	$32,622
Sewerage	487	33,244	31,229
Bridges	1,415	45,399	15,319
Highways	6,404	221,435	187,388
Earthwork, Waterways	1,579	56,151	63,625
Buildings, Public	7,923	460,076	639,159
Industrial	30,940	606,857	170,083
Commercial	15,652	351,645	135,300
Unclassified	2,700	363,760	411,653

NOTE: Minimum size projects included are: Waterworks and waterway projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.



NEW PRODUCTIVE CAPITAL

	Cumulative 1945 (50 wk.)	Cumulative 1944 (50 wk.)
NON-FEDERAL	$719,033	$427,974
Corporate Securities	191,111	107,220
State and Municipal	363,322	175,814
RFC Loans	24,600	61,940
REA Loans	60,000	20,000
Fed. Aid Highway	79,000	63,000
FEDERAL	1,049,898	1,263,800
Total Capital	1,767,931	1,713,941

ENR INDEX NUMBERS

Index Base = 100		1913	1926
Construction Cost	Dec. '45	313.48	150.69
Building Cost	Dec. '45	240.82	130.18
Volume	Nov. '45	173	76

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Hi-Bond reinforcing bars provide the strongest known grip between steel and concrete. Pull tests with Hi-Bond imbedded in concrete, show no effective slippage until after the yield strength of the bar has been exceeded. Hi-Bond bars are carried in stock for immediate shipment from our Chicago, Detroit and Cincinnati plants.

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*Reg. U.S. Pat. Off.

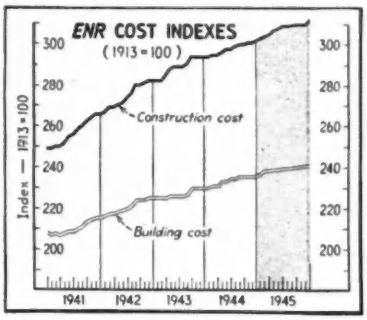
RYERSON STEEL

DECEMBER CONSTRUCTION BUSINESS REPORT

ENR CONSTRUCTION VOLUME AND NEW PRODUCTIVE CAPITAL

(,000 omitted)	November 1944	November 1945	% Change	Eleven Months 1944	Eleven Months 1945	% Change
Total U. S. Construction	$129,740	$315,709	+143	$1,636,496	$2,051,396	+25
Private Construction	34,372	232,067	+575	348,221	972,014	+179
Public Construction	95,368	83,642	−12	1,288,275	1,079,385	−16
Federal	79,390	34,856	−56	1,057,870	729,323	−31
Total New Productive Capital	39,381	38,338	−2	1,684,869	1,752,837	+4
Private Investment	39,381	38,338	−2	276,129	539,339	+95
Federal (non-federal work)	4,000	.....	.....	144,940	164,600	+13
Federal (federal work)	.....	.....	.....	1,263,800	1,049,898	+17
E N R Construction Volume Index 1913 = 100	74	173	+134	89*	119*	+34

* *Eleven-month average.*



CONSTRUCTION COSTS . . . . WAGE RATES . . . . MATERIAL PRICES

	December 1944	December 1945	% Change	Changes November to December 1944 Nov.	1944 Dec.	1944 %	1945 Nov.	1945 Dec.	1945 %
E N R Construction Cost Index, 1913 = 100	302.30	313.48	+3.7	301.09	302.30	+0.4	309.28	313.48	+1.4
E N R Building Cost Index 1913 = 100‡	236.51	240.82	+1.8	236.10	236.51	+0.2	240.55	240.82	+0.1

‡ *Does not reflect increased costs due to overtime, lower labor efficiency, delivery delays, etc.*

ENR 20-CITIES' AVERAGE

Common Labor	$0.890	$0.938	+5.4	$0.886	$0.890	+0.5	$0.917	$0.938	+2.3
Skilled Labor (av. 3 trades)	1.641	1.681	+2.4	1.641	1.641	0	1.677	1.681	+0.2
Bricklayers	1.739	1.772	+1.9	1.739	1.739	0	1.772	1.772	0
Structural Ironworkers	1.698	1.729	+1.8	1.698	1.698	0	1.729	1.729	0
Carpenters	1.487	1.550	+4.2	1.487	1.487	0	1.530	1.550	+1.3
Cement, per barrel	2.67	2.74	+2.6	2.69	2.69	0	2.74	2.74	0
Reinforcing steel, cwt	2.79	2.79	0	2.79	2.79	0	2.79	2.79	0
Structural steel base	2.10	2.10	0	2.10	2.10	0	2.10	2.10	0
Sand, per ton	1.25	1.25	0	1.25	1.25	0	1.24	1.25	+0.8
Lumber, 2x4 Fir, per M ft.	55.32	54.58	−1.3	54.58	55.32	+1.4	55.63	54.58	−1.8
Lumber, 2x4 Pine, per M ft.	53.44	53.44	0	53.44	53.44	0	53.84	53.44	−0.5
Common brick, per M	18.29	19.91	+9.1	17.22	18.29	+6.2	19.58	19.91	+1.7
Ready-mixed concrete, c. y.	7.46	7.64	+2.4	7.46	7.46	0	7.63	7.64	+0.1
Struct. clay tile, 3x12x12	82.00	89.22	+8.8	81.30	82.00	+0.9	86.33	89.22	+3.3
Paving asphalt, cars, ton	15.02	15.07	+0.3	15.43	15.43	0	15.07	15.07	0

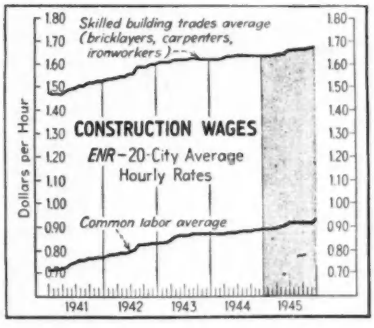
ENR INDEX NUMBERS

Base = 100	Construction Cost 1913	Construction Cost 1926	Building Cost 1913	Building Cost 1926	Volume '13	Volume '26
Dec., 1945	313.48	150.69	240.82	130.18		
Nov., 1945	309.28	148.67	240.55	130.00	173	76
Oct., 1945	309.28	148.67	240.35	129.93	167	73
Sept., 1945	309.28	148.67	240.07	129.77	164	72
Aug., 1945	309.08	148.57	239.94	129.70	119	52
July, 1945	308.99	148.53	239.64	129.54	119	52
June, 1945	308.99	148.53	239.37	129.40	133	58
May, 1945	307.43	147.78	238.46	128.90	93	41
April, 1945	306.43	147.30	238.46	128.90	99	43
Mar., 1945	304.50	146.37	237.85	128.57	103	45
Feb., 1945	303.70	145.99	237.71	128.50	78	34
Jan., 1945	302.50	145.41	236.51	127.85	63	28
Dec., 1944	302.30	145.32	236.51	127.85	66	29
Nov., 1944	301.09	144.73	236.10	127.63	74	33
1945 (Av.)	307.74	147.93	239.14	129.27		
1944 (Av.)	298.63	143.59	234.73	126.89	96	42
1943 (Av.)	289.95	139.38	228.75	123.66	176	77
1942 (Av.)	276.31	132.82	222.39	120.22	553	243

MATERIAL SHIPMENTS . . . . BUILDING PERMITS

	November 1944	November 1945	% Change	Oct. 1945	% Change Oct.-Nov.
Steel (% operating capacity) A.I.S.I.	96.0	80.8	−16	71.2	+13

	October 1944	October 1945	% Change	10 Months 1944	10 Months 1945	% Change
Fabricated Structural Steel, tons, A.I.S.C.	61,554	62,147	+0.9	477,226	623,891	+31
Cement, thous. bbl. U. S. B. of Mines	10,263	13,303	+30	82,259	89,956	+9
Building Permits, 215 cities, Dun & Bradstreet (,000 omitted)	105,542	161,851	+53	679,656	890,642	+31



COST OF LIVING INDEX . . . . CIVIL NON-AGRICULTURAL EMPLOYMENT

	October 1944	October 1945	% Change	Sept. 1945	% Change Sept.-Oct.
Cost of Living Index, N.I.C.B.	105.0	106.3	+1.2	106.2	+0.1
Rent (Housing) Index, N. I. C. B.	91.0	91.0	0.0	91.0	0.0
Total Employment (est.) thous., B. L. S.	38,360	34,908	−9.0	35,344	−1.2
Constr. Employment (est.) thous., B. L. S.	652	975	+56.0	948	+3.0

ENGINEERING CONSTRUCTION CONTRACTS — ENGINEERING NEWS-RECORD — NOVEMBER, 1945

Engineering News-Record *reports continental U. S. Construction projects of the following minimum costs—waterworks, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000

Five Weeks—Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Mid West	West of Mississippi	Far West	United States November 1945	United States Eleven Months 1945	United States Eleven Months 1944	Canada
Public Works										
Waterworks	92	1,653	361	1,289	617	4,615	8,627	53,962	30,298	2,933
Sewerage	.....	502	544	499	1,261	735	3,541	31,874	30,306	245
Bridges, public	837	2,324	1,224	469	1,310	240	6,404	36,026	13,590	85
Earthwork and waterways	19	614	2,467	1,903	1,911	1,949	8,863	54,086	62,588	238
Streets and Roads	910	5,495	3,223	1,815	7,166	857	19,466	206,475	182,756	2,098
Buildings, public	1,061	4,641	4,351	2,431	5,518	2,408	20,410	448,483	614,493	9,949
Unclassified, public	142	1,867	3,178	1,009	3,017	7,118	16,331	248,479	302,244	780
Total public	**3,061**	**17,096**	**15,348**	**9,415**	**20,800**	**17,922**	**83,642**	**1,079,385**	**1,288,275**	**16,328**
Federal government (included in above classifications)	349	4,201	8,232	2,091	7,765	12,218	34,856	729,323	1,057,870	.....
Private										
Bridges, private	.....	.....	.....	.....	.....	.....	.....	3,981	1,485	.....
Industrial buildings	4,608	14,597	14,664	31,142	12,949	30,137	108,097	545,746	166,126	2,349
Commercial buildings	2,721	50,066	2,115	15,965	20,238	16,234	107,339	312,401	131,270	2,293
Unclassified, private	565	3,194	3,385	1,244	7,429	814	16,631	109,886	46,340	1,000
Total private	**7,894**	**67,857**	**20,164**	**48,351**	**40,616**	**47,185**	**232,067**	**972,014**	**348,221**	**5,642**
Total Engineering Construction;										
November 1945 — 5 weeks	**10,955**	**84,953**	**35,512**	**57,766**	**61,416**	**65,107**	**315,709**	.....	.....	**21,970**
October 1945 — 4 weeks	9,302	52,102	11,570	58,310	54,284	53,868	239,436	.....	.....	12,136
November 1944 — 5 weeks	3,640	25,103	17,573	14,242	28,795	40,387	129,740	.....	.....	5,829
Eleven months — 1945	**85,758**	**390,690**	**283,953**	**384,132**	**430,132**	**430,201**	**576,665**	**2,051,399**	.....	**151,128**
Eleven months — 1944	48,403	247,726	266,057	197,444	317,367	559,499	.....	.....	1,636,496	105,497

To help build the Oak Ridge Atom Bomb plant in record time....

Atom Bomb Project, Oak Ridge, Tenn. Atlas High-Early Cement used for Gaseous Diffusion Process Plant and for Steam Power Plant completed in record time. Colonel Kenneth D. Nichols, District Engineer. Kellex Corporation, New York, Designers and Engineers. J. A. Jones Construction Company, Inc., Charlotte, N. C., General Contractors. Ready-mix concrete furnished by Cooney Bros., Inc., Tarrytown, N. Y.

..the contractor used

ATLAS HIGH-EARLY CEMENT

(the time-saving cement)

PRODUCT OF UNIVERSAL ATLAS CEMENT COMPANY

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SUNDAY EVENINGS—American Broadcasting Company (Blue) Network—U. S. Steel's "The Theatre Guild on the Air"

The Week In Engineering and Construction

ENGINEERING NEWS-RECORD • DECEMBER 13, 1945 • VOLUME 135 • NUMBER 24

New York not to compete with private construction

Head of public works department says state will not force costs up by competing for scarce labor and material for public projects

In a characteristically frank statement, Charles H. Sells, superintendent of the New York State Department of Public Works, told contractors of that state that its postwar public-works program will not be advanced to the contract stage actively, if that means forcing up construction costs by competing with private work for scarce labor and materials. Mr. Sells' statement was made at the 20th anniversary dinner of the New York State Chapter, Associated General Contractors of America, held in Buffalo, Dec. 6.

High bids received

At eleven lettings on 89 projects, Mr. Sells said, there had been only 44 successful bids. The others were over the engineers' estimates and so had to be rejected under state law. Of $31,200,000 of work thus offered, only $12,750,000 has been awarded. Because of this, Mr. Sells said, his engineers had been charged with not making their estimates high enough for present conditions. (The estimates had been increased 15 percent over 1940-41 prices, at which time contractors' bids averaged 20 percent below the estimates—EDITOR)

"I believe nobody will criticize the policy that public works construction undertaken by the state shall not compete with the attempts of private industry to re-establish itself," Mr. Sells said.

"It would be a simple matter for the state continually to increase its estimates, until it found some contractor willing to take the work.

"The effect of such procedure, however, on the economic situation as affecting most of the people of the state requires considerable thought. Assuming that the engineers' estimates are constantly revised upwards, inflationary values on general construction work would result.

"While the exigencies of the situation, so far as the state is concerned, might in some measure justify such action, it cannot be forgotten that it would have an effect on prices which private industry might have to pay. I do not believe that the state should lead the way in this inflationary process."

Commenting on engineers' general knowledge of the "intrinsic value of labor, materials and other matters," the official added that his estimators have a very good idea as to how far the state can afford to stretch its estimates to meet immediate needs.

"What we do not know," he continued, "is how much safety cushion a contractor might need to put into his bid to insure him against all possible losses that might result from the unsettled conditions presently surrounding the labor, material and equipments market. We do not believe we should include in our estimates leeway for such cushions to reach inflationary proportions."

"Our estimates should not be gaged to deny contractors a profit, but they should not provide a cushion.

Mr. Sells added that the department's estimates would be increased if that is found necessary by further study.

"The state has made its blueprints and arranged its finances. The construction industry must be placed in a position where it can safely and intelligently commit itself to long-term contracts with reasonable assurance that it can compute a justifiable bid with a margin of profit and be assured of opportunity to realize it."

General Farrell speaks

Major General Thomas F. Farrell, chief engineer of the New York State Department of Public Works, and at present on leave as deputy chief engineer of the Manhattan District, was the guest of honor at the dinner. He told of his experiences in connection with the dropping of two atomic bombs on

(*Continued on p.* 104)

Intensify construction wage-control efforts

The wage stabilization unit of the National War Labor Board and the Office of Stabilization Administrator, which is a part of the Office of War Mobilization and Reconversion, are planning to intensify their programs to prevent inflationary wages in the construction industry. Both agencies have assured the Wage Adjustment Board of the War Labor Board that they will assist in the strict enforcement of the war restrictions on construction wages.

Decision to push enforcement came after a country-wide check-up indicated inflationary wage increases are being given in the industry in some regions without approval of the Wage Adjustment Board, which has been necessary during the war. In the Cleveland, Miami, Norfolk, Va. and other areas of short labor supply, some extremely high wages are being paid.

The program announced does not mean, however, that no wage increases will be granted. In the past authorized adjustments have been permitted and others probably will be necessary before construction on a big scale is in progress. Employers and labor unions alike should apply to the Wage Adjustment Board for any desired increases.

In this work the petitioning groups should use Form NWLB-10 of the National War Labor Board and the completed application should be sent to Robert Moore, Secretary, Wage Adjustment Board for any desired increases. ing, Washington, D. C.

Quicker and more satisfactory action probably will be obtained if groups of the employers sign the petition along with the representatives of all the labor unions involved. The assistance of the local chapters of the Associated General Contractors in filling out and filing the applications is also helpful, officials of the labor agencies report.

NEWS IN BRIEF

In telegraphic form, here are latest news developments on the engineering and construction front during the week.

Water Supply—*Rochester, N. Y.*, asked state assistance to meet part of the costs of a planned $2,400,000 expansion program. . . . *Springfield, Ill.*, said it would spend $900,000 to expand its water plant. . . . *Seattle, Wash.*, discussed spending $6,671,000 to improve its system. . . . *Tampa, Fla.*, planned a new filter plant. . . . *North Little Rock, Ark.*, made final arrangements to purchase the city water system from private operators. . . . The *Ohio Water Resources* Board adopted new regulations governing well-drilling. . . . *Toledo, Ohio*, had $2,000,000 of improvement work ready.

Highways—*Florida* reported it had spend nearly $41,000,000 on road works during the war. . . . *Ohio* planned reconstruction of six highway bridges at a cost of $2,000,000. . . . The *Texas* highway department approved a route for the new Houston-Galveston superhighway, paralleling present U. S. 75. . . . *Calaveras County, Calif.*, announced a $3,000,000 program for 1946. . . . Work on the Harvard Street Bridge, *Peoria, Ill.*, halted by war shortages, will be resumed in the spring.

Sewerage—*Puerto Rico* planned to spend $10,344,900 on sanitary and storm-sewer work during the coming year. . . . *Chattanooga, Tenn.*, will put its unused disposal plant in suburban Brainerd into operation to lessen pollution of Chickamagua Creek. . . . *Holyrood, Kan.*, planned installation of a $66,000 disposal plant. . . . The *Los Angeles, Calif.*, Board of Public Works approved plans for a mile-long, $2,000,000 submarine outfall sewer at the Hyperion plant.

Miscellany—FWA advanced $15,000 to the Brazos River Conservation and Reclamation District to finance plans for a dam and power plant in *Hood and Parker Counties, Texas.* . . . *Louisiana* will spend $800,000 for improvements to its training school at Pineville. . . . The State of *Washington* considered plans for a $40,000,000 state school program. . . . *Houston, Texas*, approved plans for $5,830,000 in improvements to the municipal airport. . . . *Rochester, N. Y.*, said city construction projects totalling $10,000,000 and including a new city hall, were approved by the state Postwar Planning Commission. . . .

New York not to compete with citizens

(*Continued from page* 103)

Japan, where he was in general charge of the operation.

Construction equipment surplus

H. O. Penn, president of the Associated Equipment Distributors, lead an active discussion of the present prospects for construction equipment at the afternoon session. The prospects are not as good as they were a few months ago, Mr. Penn said, due to a variety of causes, the chief of which is inability of manufacturers to get needed parts such as motors and carburetors from other manufacturers. These latter firms cannot now get priorities from the government as they could in war days, and some of them are tied up by strikes.

Mr. Penn hopes to see an improvement in the construction equipment situation by mid-year. However, he noted that manufacturers are almost completely booked up with orders for their 1946 production.

With respect to surplus construction equipment in the hands of government agencies, Mr. Penn states that there are large quantities in this country and at off-shore bases. He recommended to the contractors that they put pressure on their Congressmen to get this equipment declared surplus and so released to meet current urgent demands. Released now while manufacturers are not in active production, this equipment would be a great help to construction.

Highway cost trends

Trends in construction costs as they affect highway work were discussed by V. T. Boughton, associate editor of *Engineering News-Record*, who observed that uncertainties affect almost all elements going into such costs. A survey of experience of the State Highway Departments indicates that bids on the relatively small amount of highway work on which bids have been asked have been 10 to 15 percent over the engineers' estimates. However, some states have received bids below the estimates. Engineers estimates have been raised from 15 to 50 percent over 1940 prices, estimates on shoulders being subject to the larger increases. The *Engineering News-Record* construction cost index is up 28 percent above the 1940 average.

John M. Phillips was elected president of the chapter to succeed William H. Peckham. Donald Davis was named vice-president, and Tom Fitzgerald was elected secretary-treasurer, New York State chapter of the A.G.C.

Study $100 million Philadelphia water job

A new plan for bringing upper Delaware River water to Philadelphia, Pa., involving abandonment of the polluted Schuylkill River as a water source, is being considered this week by the water commission recently appointed by the mayor of that city. The plan was prepared by a board of consulting engineers, of which Charles A. Emerson of New York is chairman. (*ENR* July 19, vol. p. 78).

The project calls for construction of a dam at Wallpack Bend near Bushkill, above the Delaware Water Gap, to store 98 billion gallons of water. This water would be released into the river cannel as required, being used there to generate about 60,000 kw. of power, and would be taken from the river at Yardley, 4 miles above Trenton, whence it would be carried 45 miles to Philadelphia in an aqueduct. This would provide the city with 500 mgd. needed to serve a population of 2,400,000, estimated adequate until the year 2,000.

Unofficially estimated to cost more than $100,000,000, the new plan would involve less outlay than any other plan put forward thus far, according to the engineers. Of the five alternate plans being considered, one drawn up in 1934 by Army Engineers proposes using the same watershed, but calls for 80 miles of aqueduct to conduct impounded water direct to the city's regulating reservoirs.

If adopted, the new plan would supplement an $18,000,000 water improvement program and a $42,000,000 sewer improvement project, for which loans have been authorized.

At *Bogota, Colombia*, the city announced construction will start soon on a bull-ring seating 20,000 spectators. . . . *Pittsburgh, Pa.*, needs 147 additional pieces of snow-removal machinery before it faces winter storms.

Construction—Rockwell Manufacturing Co. will build a $2,000,000 plant at *Pittsburgh, Pa.* . . . Bethlehem Steel Co. announced an $8,000,000 expansion at its *Vernon, Cal.*, plant. . . . Carrier Corp. will build a $2,000,000 plant at *Camillus, N. Y.* . . . The Carolinas Cement and Lime Co., newly-formed corporation, announced it would build a $1 million plant at *Harleyville, S. C.*

Reclamation Bureau engineers to aid huge China power, irrigation project

Ickes announces participation in planning Yangtse River project to irrigate 10 million acres, curb floods

Engineers of the U. S. Bureau of Reclamation will assist the government of China in working out plans for a comprehensive basin-wide development program in the Yangtse River valley, under terms of a contract signed last week.

The contract, which covers technical assistance in preparation of plans for the development, is for a total of $500,000. It was negotiated with the approval of the State Department and the Department of the Interior with the National Resources Commission of China, acting in behalf of the Chinese Government at Chungking.

Harold L. Ickes, Interior Secretary, said that bureau engineers will prepare designs and specifications for what may be the largest concrete dam ever built, and for other engineering works to control the Yangtse River.

Under comprehensive plans for resource development in the basin, water would be provided for irrigating ten million acres of land and for generating huge quantities of hydroelectric energy. The water of the river and its five major tributaries would be controlled to provide protection against floods and improve navigation.

Dam is key feature

Key engineering feature in the development plan is a dam to be larger than Grand Coulee, located in the gorge of the Yangtse River near Ichang in the heart of China (see accompanying map). This dam would back up the river into a reservoir 250 miles long.

The plan also calls for construction of numerous other dams, hundreds of miles of irrigation canals, the world's largest hydroelectric plant and other facilities.

Commissioner of Reclamation Harry W. Bashore said that the design work will be done in the Denver office of the bureau under the direction of John L. Savage, bureau designing engineer. A preliminary report on plans for the development of the Yangtse gorge project was made by Mr. Savage earlier this year. He spent several months in China in 1944 at the request of the Chinese government and under the auspices of the U. S. State Department.

Specific features of the development, according to Mr. Ickes, would include a reservoir of 50 million acre-feet capacity and a hydroelectric plant with a generating capacity of 10½ million kilowatts and other work.

It was said that due to the magnitude of the project, development work would probably be spread over a 10 to 25 year period.

California considers new road to Yosemite

The State Highway Commission of California has taken under consideration a project to build an all-year, low-level, snow-free highway, from Modesto to Yosemite National Park.

Division of the expected cost of $1,750,000, would be between the state of California and the Federal Park funds, with California assuming the larger share of the required amount, $1,000,000.

Shelved in 1941 because of the war, this project is being accelerated through efforts of an interested commission at Modesto. A statement from Secretary of Interior Harold Ickes confirms the fact that the park service considers the proposed highway one of its No. 1 postwar projects.

According to Frank Paradis, chairman of the Modesto commission, the proposed 28-mile road into Yosemite from Modesto would cut one hour's travel time from northern California points, and benefit thousands of out-of-state tourists.

Bond elections set to finance building

Cities vote on issues for civic improvement programs

Seeking means of financing much needed improvements in their civic household, the voters in many cities are considering major bond issues.

Among the largest bond issues submitted to voters was one at Dallas, Tex., where the city asked approval of a $40,000,000 loan. To be financed by the issue would be $10,000,000 in school construction; a $7,000,000 municipal auditorium; a $2,500,000 city hall; $2,100,000 of work on sanitary sewers; $1,000,000 of work on airports and various other works.

The new work would be integrated with the city's master development plan.

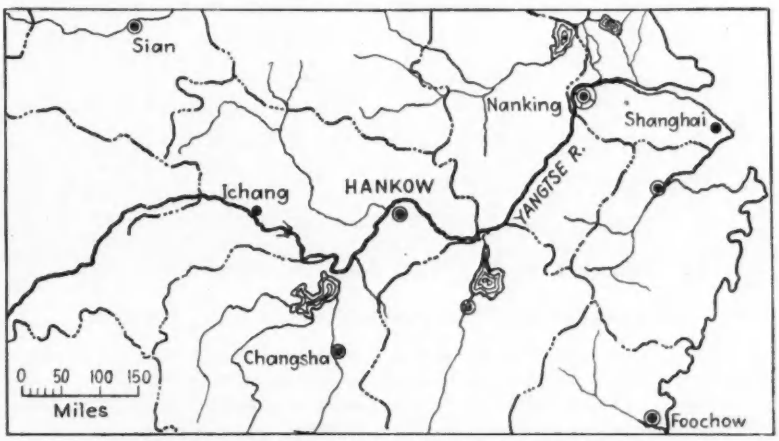
At Columbia, S. C., the city council considered asking approval for a $3,000,000 bond issue that would finance extension of water lines and sewer connections for industrial expansion, and other emergency projects.

At Baton Rouge, La., the State Advisory Board announced it would sell $2,000,000 of state highway funds to finance construction of bridges and highways in the state.

Tulsa approves issue

Voters of the City of Tulsa, Okla., and Tulsa County last week approved bond issues for civic improvements that will cost about $9,500,000.

Major projects included in the program to be financed are a $3,000,000 limited access highway program, a $3,000,000 extension and improvement program for the water supply system, and construction of additional schools, parks, and sewage disposal facilities.



Part of the 3,100-mile length of China's Yangtse River is shown above. U. S. Reclamation Bureau Engineers will aid in construction of a huge dam in the river's gorge, near Ichang.

Contractors seek share in state road repair work

A proposal that the state "farm out" under contract to private contractors some of the improvement work on county and secondary roads was recently submitted for consideration to the North Carolina State Highway and Public Works Commission.

The proposal was made by Charles Ross, general counsel for the Carolina Road Builders Association, and formerly general counsel for the highway commission. It was in line with a recent declaration by Governor Gregg Cherry who urged that the commission might depart from custom and let some of the work to contractors in the interests of getting quick action on improvements to county roads.

It has been the practice for the highway department to do much of the resurfacing and rebuilding of secondary and county roads with its own forces.

Commissioners took the suggestion under advisement but indicated that some contracts might be let as an experiment.

Supporting this proposal, Mr. Ross said that contractors are ready with materials, machinery and labor to take contracts for this work. He said that work could be done by the private interests about as cheaply as by the department itself, and that the proposal would speed up the progress of the general program.

Another suggestion presented by the contractors was a "streamlined" plan of bidding for work on secondary roads covered by the federal aid program.

Under present procedure, bids on highway work are made on the basis of detailed information compiled by the department's engineering division. The contractors suggested that the information be reduced, and contractors be allowed to submit bids upon information based only on the center line and contour of the area to be paved or repaired.

Commenting on this suggestion, Mr. Ross said that the plan would be "something of a gamble" for both contractors and the commission, but that it too would speed up construction.

Hathaway is assistant to Chief of Engineers

Gail A. Hathaway of University Park, Md., has been named special assistant to the Chief of Engineers. In addition to his new duties, Mr. Hathaway will continue to exercise staff supervision of the Reservoir Operation and Hydrology Branch, Civil Works. Mr. Hathaway recently received a Bronze Star for his Rhine River hydraulic work in the European Theater of Operations.

Reclamation Bureau names new personnel

The Bureau of Reclamation recently announced the appointment of two new assistant regional directors at Salt Lake City, Utah, and Sacramento, Calif.

Appointed at Salt Lake City was Clinton D. Woods, who becomes executive assistant to the regional director. An employee of the bureau from 1933 to 1943, Mr. Woods did work in connection with Parker Dam in California, Seminoe Dam in Wyoming, and other work. In 1943 he transferred to the Bureau of Mines.

Phil Dickinson, who will serve as assistant to the director at Sacramento, joined the staff of the Central Valley Project in 1937 as director of information; and left it to enter the army during the World War II.

Other new appointments in the bureau include that of Ben. W. Creim who has been appointed regional power manager at Sacramento. Mr. Creim, was formerly in charge of electrical construction for the Bonneville Power Administration.

The bureau also announced that it would open an office at Walla Walla, Wash. on April 1. The new office will have charge of all investigations in the drainage area north of Deschutes, Lahontan, Malheur and Burnt River basins in Oregon, east of the Cascade Summit in Washington and the area in Idaho between, but not including, the Spokane and Salmon rivers.

Washington Post photo

Engineer generals receive Chinese award

Lt. Gen. Raymond A. Wheeler, (right), Chief of Engineers, and Lt. Gen. Daniel I. Sultan, (left), Inspector General of the Army, were honored in Washington recently by the presentation of the Cloud and Banner Decoration with special Grand Cordon, by the Chinese Ambassador, Wei Tao-ming.

Highest decoration given a foreigner by the Chinese government, the award was presented in behalf of Generalissimo Chiang Kai-shek.

Both officers served with distinction in high Army positions during the past war in the China-India war theater.

U. S. engineer expelled from Ecuador project

The government of Ecuador last week ordered the expulsion of an American civil engineer, Spencer W. Stewart, manager of the Ambursen Engineering Corp., New York, and said it would take over the offices and equipment of this firm, alleging that Mr. Stewart was attempting to foment a revolution.

The Ambursen firm was engaged in building a highway for the Ecuadorean Development Corp., an agency sponsored by the U. S. Export-Import Bank, which is financing the work.

Publication of complete details will be made next week. Meantime, Mr. Stewart, who says that he has not been in Ecuador since last August, has told ENGINEERING NEWS-RECORD that the Ambursen firm owns no equipment in Ecuador. He stated that it is the Ecuadorean Development Corp. that is in default in their obligations, and that the Ambursen firm has had no contractual obligations with the Republic of Ecuador.

Shortages form block for building programs

Steel, other materials and labor found lacking as four states hold up repair and new construction

Uncertainty as to availability of materials was beginning to put a brake on major building programs, it was indicated last week. In four widely scattered states, engineers and architects reported that shortage of steel and other materials was already delaying start of work.

At Lansing, Mich., Highway Commissioner Charles M. Ziegler reported that the highway department will not take bids for any of the jobs on its construction program until at least after January 1. Mr. Ziegler said that a shortage of steel needed for highway bridges was cause of the delay.

Along the same line, the North Carolina State Highway Department announced that labor and material shortages are holding up repair work on more than 200 bridges damaged or washed away in recent floods (*ENR* Oct. 4, vol. p. 414).

Charles L. Marshall, state architect of Kansas, reported that he had completed tentative plans for six of many new buildings authorized by the 1945 legislature, but had not written specifications.

"We haven't written the specifications yet because we have no definite data as to what sort of construction materials will be available," Marshall said. The state's institutional building program for a two year period starting July 1, 1945, exceeds 5 million dollars.

Much of Ohio's $17,000,000 construction program for state mental institutions faced a threat of indefinite delay, due partially to the State Controlling Board's contention that current building costs are too high. In communications to Welfare Director Frazier Reams the controlling board said that on the few projects already put up for bidding, lowest bids have exceeded the architect's estimates and the legislative appropriation.

The board advised that the Welfare Department hold up further bidding until "the labor and material markets loosen up."

With work already under way on new diagnostic hospitals for veterans at Jacksonville and Elgin—part of Illinois' $8,000,000 hospitalization program for mentally ill veterans—award of contracts for a second building at the Elgin State Hospital was announced Nov. 27.

The new building will be a 200-bed dormitory for use of veterans.

Illinois Superhighway Act ruled valid

In an opinion handed down Nov. 21 the Illinois Supreme Court ruled that the Illinois Superhighway Act of 1943 is a "constitutional and valid statutory enactment." This was a direct reversal of a previous ruling by the circuit court of Sangamon County which had declared the act unconstitutional (*ENR*, Sept. 6, 1945, vol. p. 277).

Enacted by the state legislature in 1943, the act provided for the creation of a 5-man commission to plan, build, operate and maintain a system of toll roads to be known as superhighways. Preliminary studies have been inaugurated by the commission on certain highways in Illinois which might be built under this act. No detailed plans have been prepared to date, however, as their actual design and construction will depend, in a large measure, on the feasibility of selling toll highway bonds as provided in the act, with which to finance the work. Revenue from tax on the sale of gasoline can not be used for financing such highways, according to provisions of existing state law.

In reviewing the case, the supreme court took exception to each point on which the circuit court had based its adverse decision regarding the constitutionality of the act. Principal points of the act which were reviewed by the supreme court and upheld were: (1) The act is complete and definite . . . and constitutional in its entirety; (2) in the opinion of the high court, it does not delegate unreasonable or arbitrary authority to the administrative commission; (3) contemplated tolls mentioned in the act are not taxes and (4) it does not unconditionally amend any other act.

New York "Thruway" work starts soon

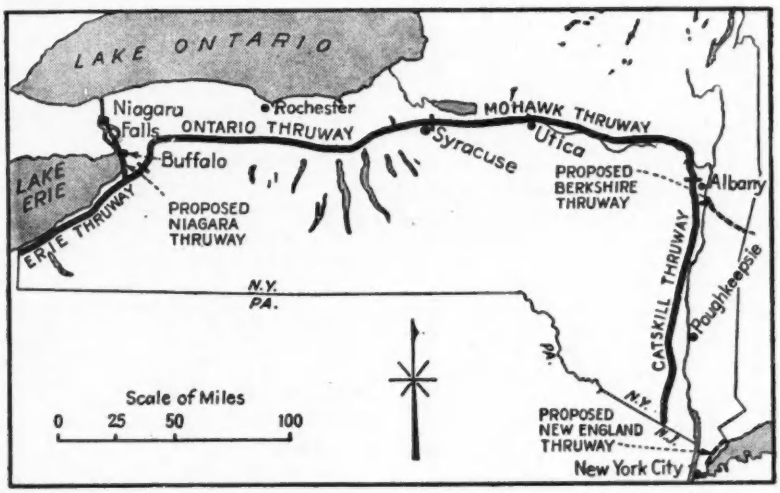
New York State's 486-mile Thruway (*ENR*, Jan. 27, 1944, vol. p. 128) will be placed under construction at three and possibly four points early in 1946, according to Charles H. Sells, public works superintendent.

As proposed, the thruway will span the state from the New York City metropolitan area to Buffalo and Lake Erie, running up the west side of the Hudson River as far as Albany and thence westward to Buffalo and the Pennsylvania state line.

Initial work will be on widely separated sectors. One project will be located on the Erie thruway section, south of Silver Creek and extending from Cattaraugus county into Erie county. Work on the Ontario Thruway in northern Ontario County in the vicinity of Victor, N. Y., will be another point, and the second portion of the Ontario Thruway and a start on the Mohawk Thruway are expected also to be part of the initial program.

The basic route of the thruway, shown on the accompanying map, has been described by legislation. Some sectional revisions in the route are now under consideration, however.

When completed the road will be a multiple-lane highway with divided arteries separated throughout by safety malls. Rights of way will have a minimum width of at least 200 ft., affording ample opportunity for further expansion when necessary. Sight distances will be no less than 1000 ft. at any point and minimum radius of curvature has been established at 2800 ft.



OBITUARY

William Carrington Dunlop, 62, Yonkers, N. Y., an industrial and public utilities engineer and consultant since 1943 with the J. G. White Engineering Corp., New York City, died Dec. 7. He received an M. E. degree from Columbia University in 1906.

Mr. Dunlop was construction engineer of the Allis Chalmers Co. in New York from 1907 to 1909, consulting engineer with Parsons, Klapp, Brinckerhoff and Douglas from 1909 to 1916, from 1920 to 1929 and from 1939 to 1943, and assistant chief engineer of the Chicago Traction and Subway Commission in 1916-1917. He was transportation engineer for the New York World's Fair of 1939.

He had been engineer in charge of the construction and installation of the ventilating system for the vehicular tunnel between Detroit, Mich., and Windsor, Ont., and consulting engineer on the vehicular tunnel project under the Scheldt River, Antwerp, Belgium.

Haakon Holdt Svanoe, 65, a civil engineer with the Wisconsin Bridge & Iron Co. of Milwaukee, Wis. died Nov. 24. Mr. Svanoe received his technical training at Dresden, Germany. He previously was with the Wisconsin State Highway Commission and the Strauss Engineering Co. of Chicago.

Harry Jones, 63, retired building construction engineer, died in Hudson, Ohio, Nov. 28.

James A. Moyer, 70, instructor in engineering at Harvard University from 1901 to 1904, died Nov. 29 in Newton, Mass. He accepted the position of director of Massachusetts state extension instruction in 1914 and organized a program which enrolled 33,000 students at its peak in 1944.

William M. Bailey, 76, president of William M. Bailey Engineering & Contracting Co., Boston, Mass., died at Malden, Dec 1. He was a graduate of the University of Maine.

Henry Tiedge, chief construction engineer for the Consolidated Mining and Smelting Co. of Canada died at Trail, B. C., Nov. 24.

George N. Mayerhoff, 49, civil engineer at Memphis, Tenn., died at Colrado Springs, Colo., Nov. 16.

Elmer Keller, 74, civil engineer and for many years county highway engineer of Pipestone County, died at Pipestone, Minn., recently.

Charles A. Perkins, 87, professor emeritus of the College of Engineering, University of Tennessee, died in Knoxville, Tenn., Nov. 26. He joined the faculty in 1932 and was director of the school's engineering experiment station.

E. A. Kingsley, city engineer of Dallas, Tex., from 1923 to 1927, died in Salinas, Calif., Nov. 15. After leaving the city service, Mr. Kingsley served as engineer with Koch & Fowler, engineers of Dallas, and as engineer of the National Park Service in Dallas and Amarillo.

James B. Fulton, 89, city engineer of San Diego, Calif., in 1887 and 1888, died Nov. 19.

Roger Daoust, 67, Defiance, O., who entered the road-building contracting business in 1917, building roads in Ohio and Indiana, died Nov. 14.

CONSTRUCTION FOR ATOMIC BOMB FACILITIES

Reprints of the 45-page section in this issue on construction for production of the atomic bomb are now available at 25 cents per copy.

Address requests to The Editorial Department, Engineering News-Record, 330 West 42nd St., New York 18, N. Y.

William Phelps Eno dies, highway traffic expert

William Phelps Eno, 87, who was responsible for New York City's first highway traffic regulations and the originator of one-way streets, rotary traffic and safety islands, died in Norwalk, Conn., Dec 3.

The first experiments at traffic control in New York were undertaken at Eno's insistence in 1902. Under Police Commissioner William McAdoo, the block system of alternating cross traffic at intersections was established.

Eno's rotary traffic plan was put into effect at Columbus Circle in 1905 and later in Paris at the Arc de Triomphe and Ronde Pointe on the Champs Elysees. For his traffic work in France he was awarded the French Legion of Honor.

In 1921 he endowed the Eno Foundation for Highway Traffic Control—a non-profit scientific study center affiliated with Yale University.

In World War I his road traffic control code was used by the Allies and it was used again in the recent war by Allied forces in North Africa.

Long-range planning urged for state roads

Southeastern highway officials hear need for planning, higher pay; elect Virginia roads chief as new president.

State highway officials must cease to look on their immediate programs as a "blood transfusion" for the national economy, but must rather consider construction for the greatest good of their states from an economic and social viewpoints, southern highway officials were told last week.

Meeting at Atlanta, Ga., more than 400 members of the Southeastern Association of State Highway Officials discussed current trends in their field, and elected a new slate of officers. C. S. Mullins, chief engineer of the Virginia Department of Highways was elected president for the coming year, succeeding Ernest L. Bailey, chairman of the West Virginia State Road Commission.

C. S. Mullins

Speakers outlined three major considerations for the group, looking toward improvement in the highway program. They were:

1. Careful, long-range planning of state road programs, emphasizing service and economic worth rather than employment,

2. Undertaking by the departments of programs aimed at educating governmental units within their states to promote cooperation with the state in overall planning.

3. Increases in pay for highway engineers to give incentive to younger men to enter the field and remain in it, and to insure the high caliber of highway staffs.

The current increase in construction costs, faced by many states recently and attributed generally to the factors of shortages of labor and materials, was tied to needed changes in design specifications by Charles M. Upham, engineer-director of the American Road Builders' Association. "A case study of cost analysis of highway construction definitely points to the fact that highways of the future are going to be more expensive," Mr. Upham said. "Not only is this true due to more elaborate design to take care of traffic demands and to produce safer highways, but all indications point to the fact that the elements making up the cost of the unit items will be greater than any time in the past."

Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

Spillway Pier Erosion

Sir: Mr. Streiff (*ENR* Aug. 23, vol. p. 220) describes a number of cases in Europe where measures were necessary to protect gate guides from damage by erosion.

It is opportune to remark that similar troubles have not been experienced on the Shawinigan Water & Power Co. system where a number of gates 40 or 50 ft. wide and up to 30 ft. high have been in constant use for many years. The shape of the pier noses perhaps explains this freedom from damage; they all tend to keep the water away from the gate slots as does the type shown in Fig. 5 of Mr. Streiff's letter, though they have rectangular gate slots which give simpler details for bedded parts, seals and heaters.

The Bonneville experience which Messrs. Galbraith and Clark were kind enough to publish gives a warning that this deflecting effect diminishes with greater depths.

J. B. MACPHAIL
The Shawinigan Engineering Co. Ltd.
Montreal, Canada

Soil Mechanics De luxe

Sir: For years there have been constructed a very large number of earth dams throughout the world and there has been a change in the design and method of construction from one era to another. In our own lifetime, we have advanced from the slip, fresno, wheel-scraper methods of construction, to the era of the heavy trucks, carry-all and tractor stage. On the design and specification side, we have progressed from the selection of material by the off-hand judgment of the engineer, to the modern methods of soil mechanics and all its weird applications to the suitability of material for dam construction. The writer does not wish to criticize the results of the modern system of soil mechanics nor the importance of moisture control during the process of construction, but the question arises, are we not carrying this business too far.

Just recently, the construction of the Merriman Dam in New York state was advertised under specification calling for the compaction of the material with the optimum moisture contents. The borrow pits for this dam, when the writer visited the site, had water seeping out of short drifts dug in to the side of the hill. The rainfall and snowfall in the area also added to the difficulty of placing the material with the proper moisture contents. The question is this, is it worth the additional cost to obtain this degree of compaction or can a safe and satisfactory dam be constructed using the material with more than the theoretical water content? Couldn't the impervious section of the dam be increased slightly to obtain the same result? This line of argument may be contrary to the present trend in earth-dam construction, but satisfactory earth dams were constructed before all this knowledge and experiments on compaction and shear were thought of.

It is understood that there are earth dams under consideration in western Oregon where the working season, in which an approach to the optimum moisture content could be obtained without artificial drying, will not exceed one hundred days each year. The cost of these structures will be increased enormously by adhering to the specification for the maximum compaction obtainable.

Hundreds of earth dams were constructed before the advent of the Proctor method and the records of failures of earth dams throughout the United States does not reveal many failures due to seepage through the dams themselves. The writer has constructed under his supervision twenty-two dams and some of them have been in service over thirty years and are still giving excellent service. It is my opinion that it is just as good engineering to build a satisfactory structure at the least cost using the material at hand under the existing conditions as it is to build a monument to one's technical knowledge regardless of costs.

It is not intended to belittle the accomplishments of those engineers who have done so much to develop the present knowledge of soil compaction, but rather to point out that high earth dams were constructed, and can be again, without adhering to the strict requirements of all the rules relative to moisture contents.

About 1907, the Bureau of Reclamation constructed by contract the Belle Fourche Dam in South Dakota. The material was a heavy wet gumbo, so wet that at times the rollers bogged down. Of course, that was before the sheeps-foot roller was in use. At the same time, the bureau was building by its own force, the Upper Deer Flat Dam south of Nampa, Idaho. The material for this dam was obtained from borrow pits at each end of the dam and the material was a mixture of sand, gravel and top soil, all very dry. The material was wetted down, after being spread to about a 6-in. layer, by water wagons and rolled. The amount of water varied from time to time. On both of these jobs, a satisfactory dam was obtained at a minimum cost to the water user without the expense of drying the material on one or spending a lot of money for moisture control on the other.

There isn't the slightest doubt but that a safe and satisfactory dam could be built at the site of the Merriman dam by using the material from the borrow pits without drying. And this is also true of several other dams to be constructed in areas of excessive rainfall.

R. M. CONNER
Consulting Engineer,
Los Angeles, Calif.

Grand Coulee Circular Drydock

Sir: There is an error in the last paragraph of the article "Circular Drydock at Grand Coulee Dam" (*ENR* July 19, vol. p. 72) which states that I was ". . . in charge of design and operation of the caisson."

This should read ". . . in charge of the model investigations relative to the design and operation of the caisson."

JAMES W. BALL
Engineer, U. S. Bureau of Reclamation
Denver, Colo.

EDITORIALS

VOLUME 135 NUMBER 24

December 13, 1945

Public Works Deferment

THE BLUNT STATEMENT of Charles H. Sells, superintendent of the New York State Department of Public Works, that he does not intend to let the department's postwar public-works program compete with private industry for scarce construction labor and materials, (see p. 103) needs to be taken seriously elsewhere in the country, notably in Washington. Too many plans for postponable public work are being advanced actively just as if there were no scarcity of men and materials for badly needed construction such as housing. Preparation of a big postwar program was advocated during the war period as a means for providing employment should widespread unemployment develop. Unemployment has not developed, but many public agencies are going right ahead with plans to put their work under contract regardless of the need for the particular project. This is not to say that much of the public work is not needed, for it is. But there are flood-control projects, irrigation schemes, and some highways and parkways that can wait until men and materials are more plentiful. Cities, states and departments and agencies of the federal government would perform a public service by carefully examining their public works programs for projects that logically could be deferred. Not only would the construction picture be improved by such deferments, but taxpayers would benefit from lower costs to be expected later on.

Government or Business?

AMERICAN ENGINEERS will read with mixed feelings the announcement that the Bureau of Reclamation has entered into a half-million dollar contract with the National Resources Commission of China for engineering work on a great power and irrigation scheme on the Yangtse River. On the part of some there will be pride in the fact that American engineers are to participate in a great though somewhat visionary engineering project, but there will be many others who will see in this contract culmination of a trend they have long feared—direct competition from a government bureau. In the past, private consultants have done this kind of engineering for the Chinese and other governments, Hugh L. Cooper's work on the Dnieper River in Russia being an outstanding example. There may be circumstances such as the unsettled condition in China that make this unusual contract necessary, but that is not apparent in the announcement by Secretary Ickes who characterized it as "another step in cementing the friendly relations between the United States and China." Private consultants will ask with reason whether the bureau has so little American work to do at this time that it can readily take on this Chinese contract, and if not, whether it plans to expand its staff or to farm out the work to private consultants, acting in part at least as agents for the Chinese government. In view of the peculiar international conditions existing today the contract should not be condemned offhand, but it would make for more tranquil minds in the field of private enterprise if the bureau would detail more specifically the reasons for and the probably future course of such design contracts.

Changes at Panama

EXPERIENCE in handling war traffic through the Panama Canal has dictated a restudy of the project for construction of a third set of locks that was authorized in 1939 (*ENR* Nov. 22, vol. p. 695). The lock chambers as then proposed are not wide enough to permit passage of the latest type of airplane carrier, and it now appears that more anchorage is necessary. Also, some people hold that the advent of rockets and the atomic bomb has made construction of a sea-level canal a necessity. This latter proposal appears to be more emotional than practical. If atomic bombs are to be an instrument of future warfare, their disruptive force is believed to be so great that the type of canal—sea-level or lock—in a future attack would be unimportant. Either could be put completely out of service for an indefinite period, and we surmise that the sea-level canal, with its much deeper cuts, could be more effectively blocked from a single lucky bomb hit than could a locked canal. What appears to be a more realistic appraisal of the present situation is recognition of the fact that in undertaking to cut the canal down to sea level in the questionable belief that it could thus be made safe against a bomb attack of unknown magnitude we may well be inaugurating another period when landslides will block the canal completely or restrict its channel for many months on end. Completion of the third-lock project, on which $75,000,000 already has been spent, with

such modifications as the proposed study may indicate, would cost only a small fraction of the expenditure involved in a sea-level canal and would insure uninterrupted use of the lock canal in the years that lie ahead. The projected restudy is a wise and necessary precaution before construction is recommended.

Construction and Atomic Energy

One of the great military assets of the United States, if not the greatest, is its ability to conceive, design and manufacture war-waging products more rapidly than any other nation. And dominant and controlling among all the factors contributing to this ability is the role played by the American construction industry in providing the necessary facilities. Time and again during World War II engineers and construction men delivered these facilities until finally we were able to overcome the initial advantage that our enemies had in their large professional military machines and prewar preparedness.

This ability to originate, design and construct is perhaps nowhere better illustrated than in the production of the atomic bomb, an entirely new field of endeavor in which only minute experimental quantities of material had been produced before some of the greatest industrial processes and plants of all time were planned and built. Credit for the vision required to launch the project goes in large measure to the scientists who said an effective atomic bomb was attainable. Another full share of credit, of course, is due those who designed and built equipment never before conceived for processes never before known. But there still is plenty of honor for all those who shared in physically constructing the great plants, who figuratively and actually put a foundation under and a roof over an entirely new industry. As Col. Kenneth D. Nichols, district engineer of the Manhattan District, which has directed the construction, puts it, "These people and organizations—scientific, engineering, contracting, manufacturing, procuring and others—working in close harmony among themselves and with government agencies, deserve unlimited credit for the successful accomplishment of an almost impossibly vast and complicated task."

What the services of construction contributed to the accomplishment is detailed for the first time in this issue, which is devoted entirely to the atomic bomb project. From a construction point of view, the plants for production of atomic bombs are equal in cost and labor to building a Panama Canal each year for three consecutive years. Costing more than $1.5 billion and at the peak requiring the services of 150,000 people, the facilities include two major plants at the Clinton Engineer Works in Tennessee, one at the Hanford Engineer Works in the state of Washington, and one smaller unit in New Mexico. Every type and classification of construction was involved—surveying, excavation, concreting, steel erection, road building, water supply, sanitation, steam and electric power generation and factory and residence building—and above all there was the tremendous task of field construction organization, including the marshalling of unbelievably large quantities of materials. Only a nation whose peacetime form of government and busines enterprise had fostered the development of men and organizations capable of taking such an assignment in stride could have achieved success in the short time that was available.

But success is relative. The abilty to release untold amounts of atomic energy creates vast new problems that demand new successes in their solution. On the one hand are the frightening responsibilities inherent in the availability of atomic bombs, and on the other the possibilities in adapting the energy in fissionable materials to peacetime power production. With respect to the first, an editorial by James H. McGraw, Jr., facing p. 156 of this issue, outlines the social and military aspects of controlling the use of the atomic bomb, which no one interested in the preservation of civilization can afford to ignore. As to the peacetime uses of atomic energy, engineers and construction men will have no less interest in the outcome. Already, the great volume of heat released as a byproduct of the plutonium "piles" at Hanford foreshadows a huge new source of power. What more the future holds is unknown, but whatever comes is sure to require the services of construction. And when it does, the success achieved by the Manhattan Engineer District and its construction contractors will stand as a guarantee that American engineering and construction will be equal to the tasks demanded.

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CONSTRUCTION

For Atomic Bomb Production

CONSTRUCTION for production of the atomic bomb was probably the largest and most rapid coordinated building job ever undertaken. In less than three years, nearly $2 billion was spent for the materials and labor of construction, for process equipment, and for what undoubtedly is the greatest research and development program ever undertaken by any group under any conditions. Yet despite its size and speed of construction the project has been completely shielded from public knowledge, a blackout that still envelopes the manufacturing processes, but which is now lifted as respects the design and construction of the plant facilities themselves. The articles in this special issue comprise the first presentation of the construction story of the atomic bomb project.

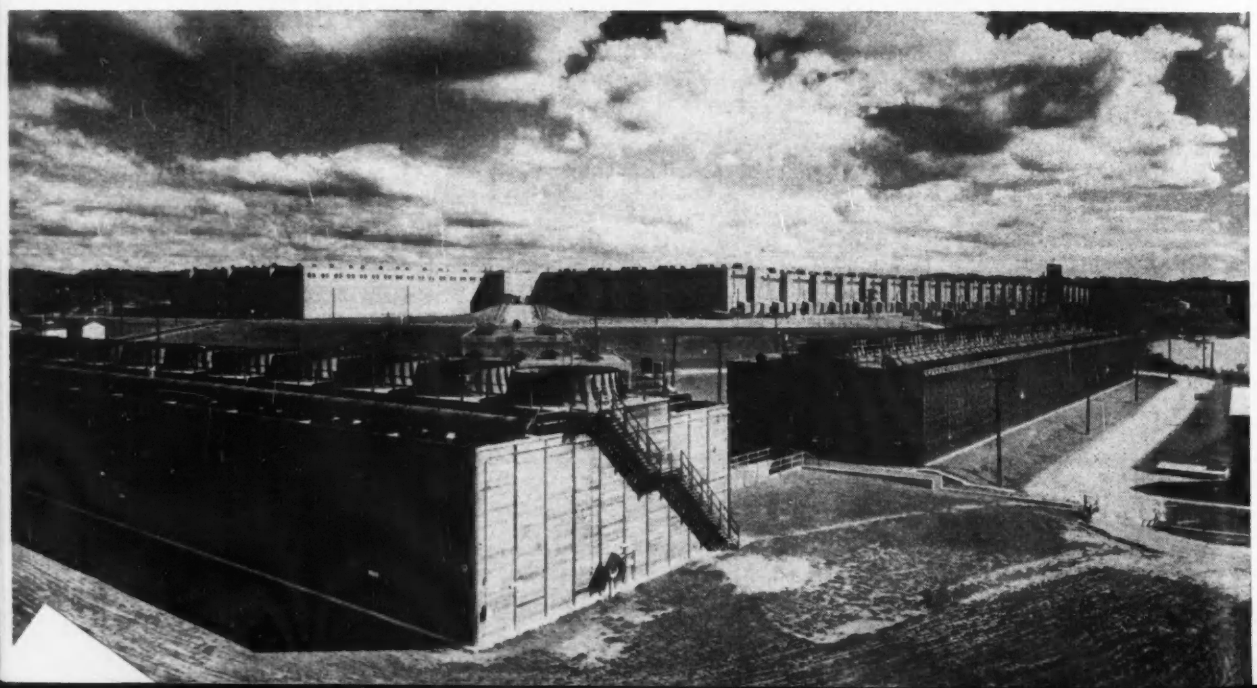
The principal facilities required to effect atomic fission and produce the bomb are located at three sites as follows: The Clinton Engineer Works near Knoxville, Tenn., which includes an electromagnetic plant, a gaseous diffusion plant and a thermal diffusion plant providing three processes for the separation of U-235, a "semi-works" or pilot plant for plutonium production and the town of Oak Ridge, all of which cost $1 billion.

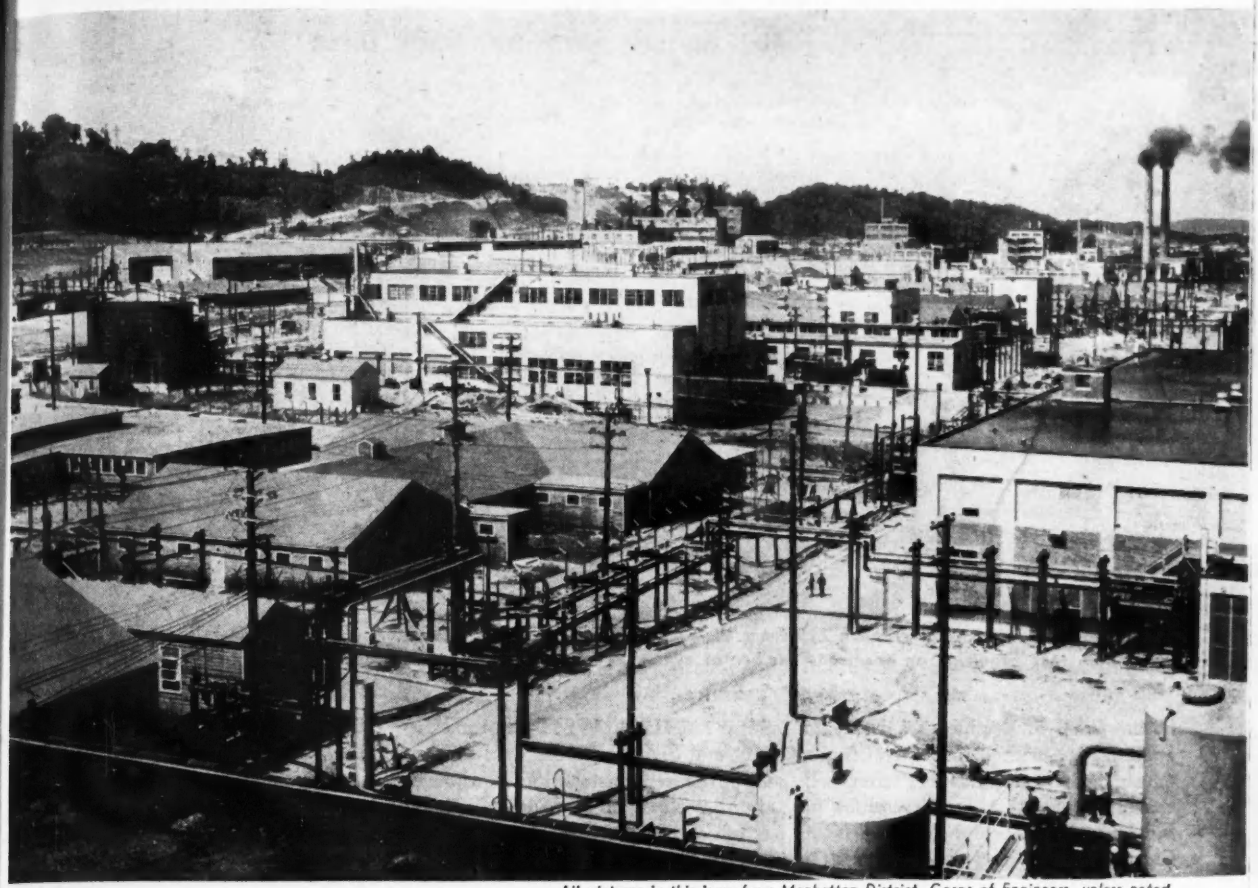
The Hanford Engineer Works in the state of Washington was built on a 400,000 acre site and 45,000 construction workers were employed to build a plutonium plant in 1½ years at a cost of $342,000,000. Research and bomb assembly facilities were provided at Los Alamos, near Santa Fe. N. M., to which materials made at the Clinton and Hanford works were shipped and which cost $55,000,000.

To appreciate the reason for, and to a certain extent the methods required for building these facilities a brief review of the history and the fundamental physics of atomic fission (see the 8-page insert on this subject in *ENR* Aug 31, 1945) will be helpful.

Scientists had learned by 1939 that atomic fission using uranium was possible, and its properties for military use were discussed at that time. However, studies of the means of separation into usable elements were for some time carried on only as individual scientific experiments. By the summer of 1940 the National Defense Research Committee had been formed, and with some money from the Army and Navy Departments, intensive research was started. By December, 1941 several universities and a few private laboratories were doing more

Gaseous diffusion plant at Clinton Engineer Works for mechanical separation of Uranium 235 from Uranium 238.





All pictures in this issue from Manhattan District, Corps of Engineers, unless noted

A large number of inter-related buildings was required at the Clinton Engineer Works for the electromagnetic process of separation of uranium isotopes.

or less coordinated work under contracts totaling about $300,000, and soon thereafter all efforts to produce an atomic bomb were consolidated under the Office of Scientific Research and Development.

By the spring of 1942 it was established that six separation or production methods were about equal as to possibility of success and all were nearly ready for pilot plant construction. These were: The centrifuge, gaseous diffusion, thermal diffusion and electromagnetic methods of separating U-235; and the uranium-graphite pile and the uranium-heavy-water pile methods of producing plutonium. Accompanying sketches show diagramatically the fundamental physics involved in these various methods.

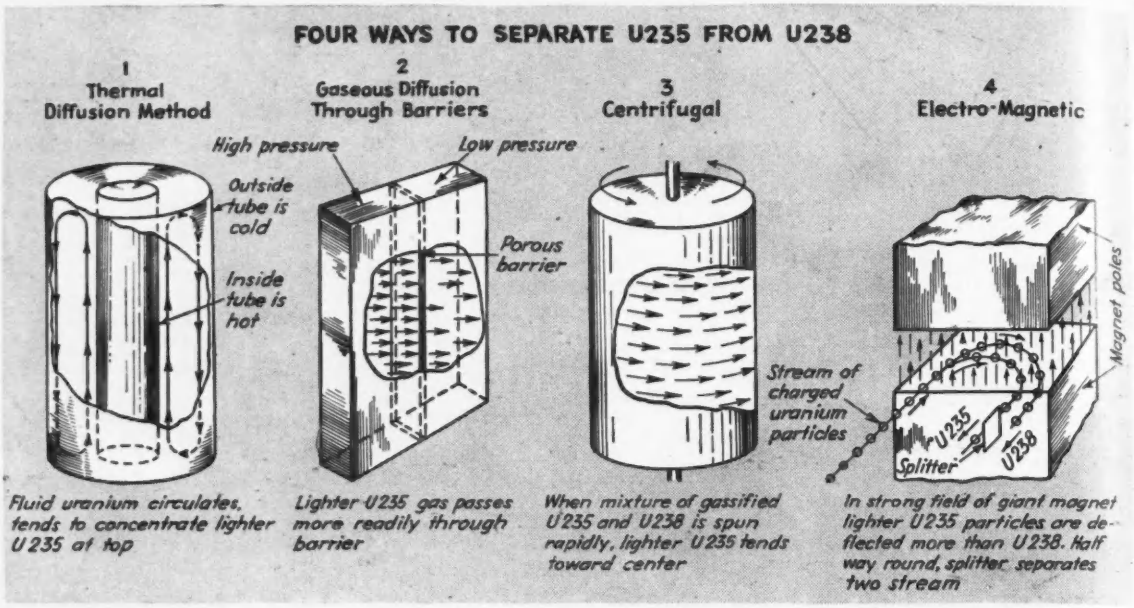
It seemed certain that if we could devise such a variety of ways of making the materials for an atomic bomb, our enemies also could find means of achieving the same end. And since it was known that the Germans were making progress in this direction and that an atomic bomb was one of the "secret weapons" that Hitler kept promising his troops, the urgency injected into our efforts is explained.

Production by several methods

Not enough scientific information was available, however, to estimate the relative merits of the several different production methods so that our energies could be concentrated on only one; and if we chose a less efficient or slower one than the Germans the results might be disastrous. Accordingly, there was no alternative but to develop simultaneously all of the plants. As it worked out, however, only three of the methods were brought to the large scale production stage; the centrifuge method for U-235 was used only in a pilot plant and the heavy-water pile method for production of plutonium was carried only to where it could safely be discarded in favor of the uranium-graphite pile.

As developments progressed beyond the experimental stage the Army Corps of Engineers was brought in to direct the construction of full scale plants, and in June, 1942, the Chief of Engineers instructed Col. James C. Marshall (now Brig. Gen. Marshall, in charge of the Boston Port of Embarkation) to form the "Manhattan Engineer District," which for security was labeled the "DSM (Development of Substitute Materials) Project." In September Brig. Gen. (now Maj. Gen.) Leslie R. Groves of the Corps of Engineers was given full responsibility for activities relating to the DSM project, and in the spring of 1943 the Manhattan District took over all research and development contracts from the OSRD. Since that time all work on the project has been directed by the Manhattan District, carrying out the ideas of the scientists working on the project. General Groves' headquarters and a district liaison office have been maintained in the Office of the Chief of Engineers in Washington during the entire construction period.

The Manhattan District is unique

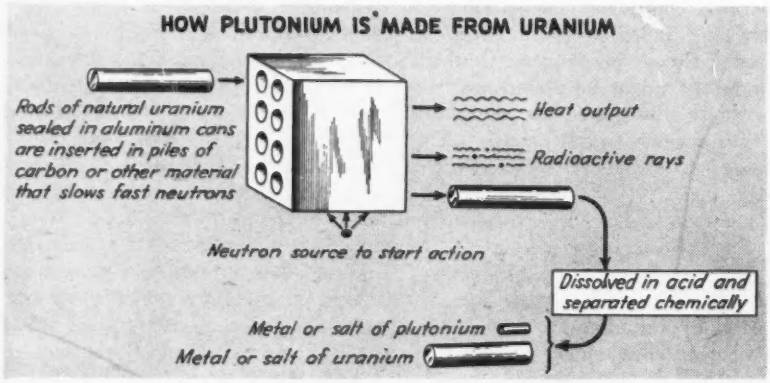

FOUR WAYS TO SEPARATE U235 FROM U238
1
Thermal Diffusion Method
2
Gaseous Diffusion Through Barriers
3
Centrifugal
4
Electro-Magnetic
High pressure
Low pressure
Outside tube is cold
Inside tube is hot
Porous barrier
Stream of charged uranium particles
Magnet poles
U235
U238
Splitter
Fluid uranium circulates, tends to concentrate lighter U235 at top
Lighter U235 gas passes more readily through barrier
When mixture of gassified U235 and U238 is spun rapidly, lighter U235 tends toward center
In strong field of giant magnet lighter U235 particles are deflected more than U238. Half way round, splitter separates two stream

All methods of separating Uranium 235 from Uranium 238 increase the proportion of U 235 only slightly in any single operation, thus requiring an enormous number of cycles to achieve usable separation.

in the Corp of Engineers as it is an organization without territorial limits to supervise contracts for construction and operation in all sections of the United States and some parts of Canada, with other contracts covering an even wider field. Headquarters have been at Oak Ridge, Tenn., since August 1943 from which stemmed not only supervision of the Clinton and Hanford Engineer Works but that of the area offices as well. These latter offices, set up wherever required in the country were separate from the established geographical district offices of the Corps of Engineers so that knowledge of significant phases of the work could be restricted to a minimum number of persons. In many cases facilities of the normal district and division offices were utilized to purchase construction equipment and materials and to acquire land, but activities beyond these were handled within the separately established organization.

The Manhattan District, however, has functioned as do similar districts under the Chief of Engineers in making contracts and directing work. Most of the construction has been done under fixed-fee contracts, the Manhattan District selecting architect-engineer-manager firms who did some of the work with their own forces and contracted with others for materials and services, wherever possible on a lump-sum or fixed-price contract. The work accomplished at Clinton and Hanford in a three year period is the equivalent of building a Panama Canal each year.

The articles in this issue are concerned only with major construction in the United States under direction of the Manhattan District. Readers may note that nothing is presented relative to the construction of the facilities at Las Alamos, N. M. and that there sometimes seem to be omissions of detail in some of the other articles. These shortcomings result from security restrictions or just lack of space in telling a $1,500,000,000 construction story in a single issue. Beyond this, however, the issue will be found to unfold a construction story of uncommon scope and interest. As Col. Kenneth D. Nichols, district engineer of the Manhattan District since Aug. 1943, describes it, the atomic bomb project is an "accomplishment which will endure as a monument to the ingenuity, vision and determination of all those, from scientists to laborers, who have had a part in the work. These people and organizations—scientific, engineering, contracting, manufacturing, procuring and others—working in close harmony among themselves and with Government agencies deserve unlimited credit for the successful accomplishment of an almost impossibly vast and complicated task."


HOW PLUTONIUM IS MADE FROM URANIUM
Rods of natural uranium sealed in aluminum cans are inserted in piles of carbon or other material that slows fast neutrons
Heat output
Radioactive rays
Neutron source to start action
Dissolved in acid and separated chemically
Metal or salt of plutonium
Metal or salt of uranium

Atomic energy can be released from plutonium, an element produced by man from uranium. Special shielding is required for protection against radioactivity.

Clinton—a Monument to Teamwork

Clinton Engineer Works, constructed at a cost of more than a billion dollars, is composed of several huge plants built by the cooperative effort of some 47,000 persons— a great achievement.

Col. Earl H. Marsden
Executive Officer, Manhattan District, Corp of Engineers

MOST EXTENSIVE of the great industrial plants developed for production of the atomic bomb is the Clinton Engineer Works, which also has served as the headquarters of the Manhattan Engineer District. Three methods of separation of uranium isotopes are carried on at CEW—electromagnetic, gaseous diffusion and thermal diffusion, and in addition there is a pilot plant for plutonium production. Together with the city of Oak Ridge the Clinton facilities cost $1,000,000,000, thus, far exceeding the initial cost of any industrial plant anywhere in the world. More important, the plants stand as a monument to the imagination and clear vision of scientists, to the confidence of American engineers that no problem is beyond solution and to the ability of American construction men—laborers, craftsmen and executives alike.

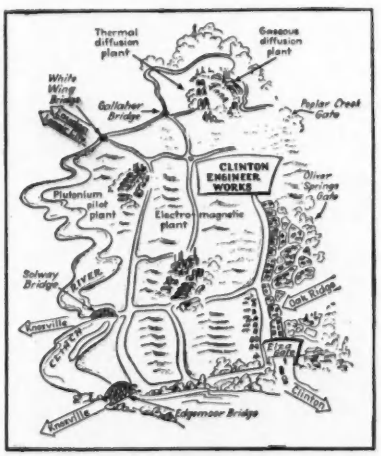
Clinton Engineer Works had to be safe from air attack, not too close to centers of population, and large enough to accommodate four separate plants. It had to have dependable electric power in large quantities, flat building areas separated by natural barriers, and a town site of at least 5,000 acres. And it had to be accessible to rail and motor transport, and on land of low agricultural value adjacent to a dependable water source.

Such a location was found along the Clinch River a few miles downstream from Norris Dam and 18 miles west of Knoxville, Tenn. Here, a rectangular area of 59,000 acres of marginal farm land with a washboard topography was acquired in the fall of 1942 at a cost of $2,600,000 under the cloak of the name "Kingston Demolition Range." The northeastern corner of the reservation was set apart as a site for the town of Oak Ridge, which was started in early 1943. South of the town were established warehouses, lumber and equipment yards, and beyond them were the plant sites.

Electromagnetic separation plant

The engineering-construction firm of Stone & Webster Engineering Corp. was chosen to design and construct the electromagnetic plant and to manage most of the "central facilities" construction, that is, the town and the utilities that served both it and the plants. The contract eventually called for plant construction estimated to cost in excess of $300,000,000, for which the design and construction firm received a fee of less than one percent.

Ground was broken for the first plant building in February, 1943 and the first production unit was in use by the operating contractor, the Tennessee Eastman Corp., in January, 1944. The peak of plant construction was reached in July, 1944 when a total of 13,200 construction workers were on the payroll. The electromagnetic process requires a large amount of electric power, which is provided by the Tennessee Valley Authority.



Clinton Engineer Works has three major plant areas and the town site—all separated by mountain ridges.

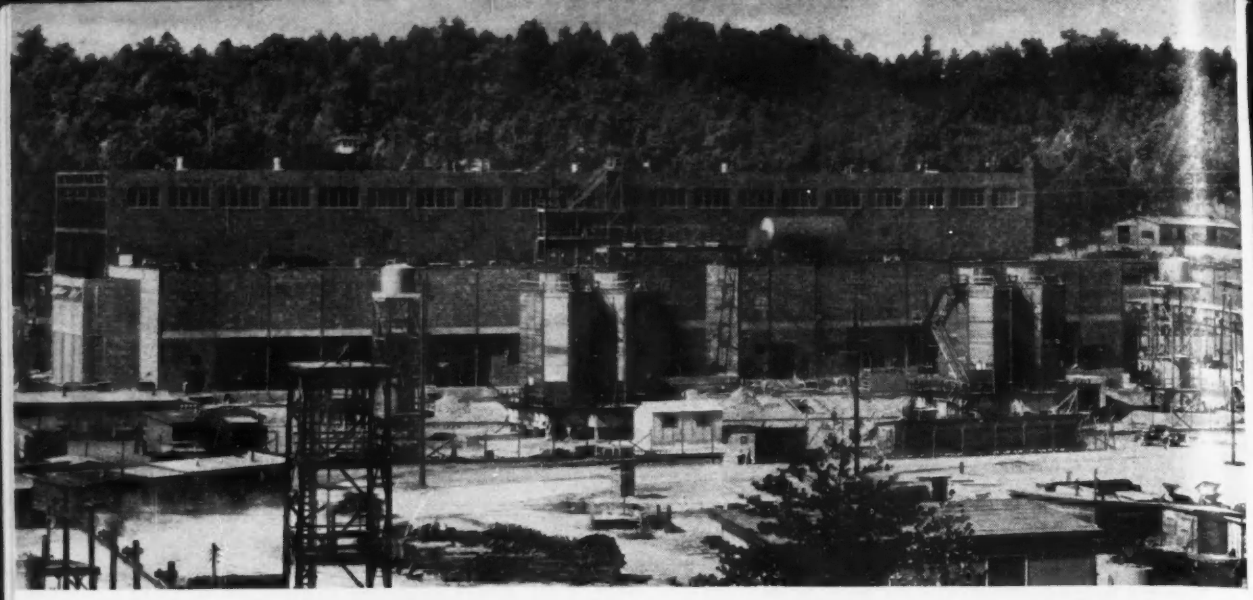
E. I. duPont de Nemours & Co. designed and built a small plutonium plant, now known as Clinton Laboratories, upon which the design of the Hanford Engineer Works is based. Interesting construction included an underground tank farm for the storage of radioactive waste.

Also, Haydite (burned clay), sand and barium chromate coarse aggregate were used for concrete shields in the process building to increase the absorption of lethal rays. The plant was started in February, 1943, and operation got under way in October of the same year. Construction cost was about $12,000,000, and peak employment reached 3,247. Until July, 1945, the plant was supervised by the University of Chicago and now is operated for experimental purposes by the Monsanto Chemical Corp.

Gaseous diffusion plant

In the spring of 1943, design work was started on a gaseous diffusion plant by the Kellex Corp., a unit of M. W. Kellogg Corp. of New York, which also handled supervision of construction and procurement of equipment. Chief construction contractor was J. A. Jones Co., Charlotte, N. C., while Ford, Bacon & Davis, Inc., designed, constructed and for a time operated an auxiliary 400x1,000-ft. plant to "condition" equipment before placement in the process plant. This entire plant is operated by Carbide and Carbon Chemicals Corp.

A high-temperature, high-pressure variable-frequency steam power plant was designed by Kellex Corp. and Sargent & Lundy of Chicago and constructed by J. A. Jones Co. at a cost



One of main buildings of the electromagnetic process with cooling towers in foreground. The end of the steel frame building was left open temporarily to facilitate installation of heavy equipment.

of $34,000,000. Generating equipment with a capacity of 238,000 kw. was installed. The paradox of this gigantic steam plant in the heart of the TVA region is explained by plant requirements for variable frequency current and necessity for minimizing possibility of interruption of power.

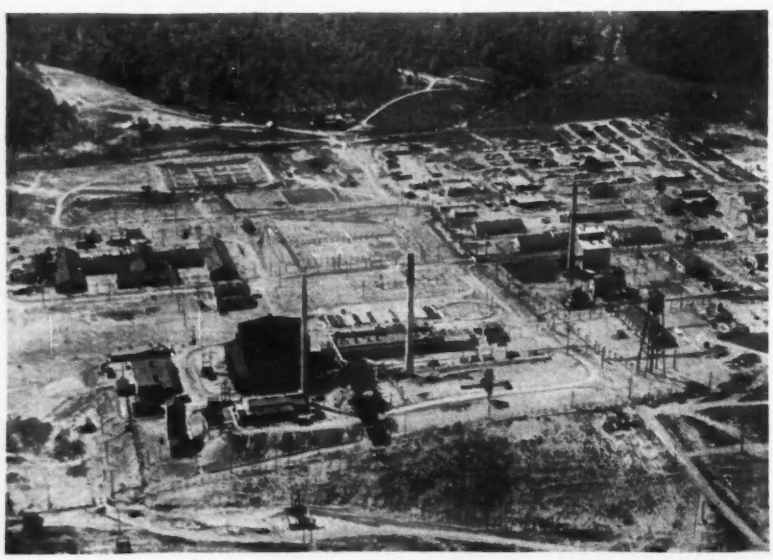
The distance of the gaseous diffusion plant from the town site, and the fact that all living quarters and eating facilities already were overcrowded, made necessary the establishment of a construction city, in addition to Oak Ridge, which reached a population of 12,000. The camp, complete with shopping and recreation facilities, was constructed by J. A. Jones Co. and Ford, Bacon & Davis.

The entire gaseous diffusion plant, including auxiliary plants but excluding the power plant, is estimated to cost $500,000,000. A labor peak of 25,000 was reached in May, 1944.

Thermal diffusion process

To provide enriched feed to the electromagnetic process, what is known as the thermal diffusion plant was constructed. The plant was designed and constructed by the H. K. Ferguson Co., Cleveland, with operation handled by a Ferguson subsidiary, Fercleve. This is a relatively small job in comparison with the other plants, the main building being 82x522 ft. Twelve oil-fired marine boilers, originally intended for destroyer escorts, were procured from the Navy and remodeled to supplement steam from the main power house. A tank farm of 6,000,000-gal. capacity was built for fuel storage. The entire job cost $10,500,000, and was built in five months, the first unit coming into operation in only three months.

The town of Oak Ridge, which was built from "scratch" in two and one-half years to become the fifth largest in the state, cost about an even $100,000,000, including utilities and services for the town and the nearby electromagnetic production plant. Some 15,000 family units and 30,000 bachelor quarters were built on the area with all necessary commercial and social facilities. Oak Ridge was planned by Skidmore, Owings and Merrill, and built by contractors under the general direction of Stone & Webster Engineering Corp.



Plant at Clinton Engineer Works built by duPont as pilot plant for plutonium process and now operated as "Clinton Laboratories".

Labor was hard to get and to keep

A total of 110,000 construction workers was hired from the time ground was broken in November, 1942 until early August, 1945. The construction peak was 47,000, reached in April, 1944, while at the same time other personnel was working in the first units of the plant to be put in operation. Procurement of

this vast amount of labor was a major undertaking in itself, on which the War Manpower Commission and the United States Employment Service, as well as union leaders and their organizations, rendered herculean service to help the contractors and the Army secure workers.

Every reasonable effort was made to provide all the necessities and as many as possible of the niceties of life to attract workers and keep them on the project after they arrived. Living quarters of every type were constructed—from the war-engendered 16x16-ft. hutments through trailers, dormitories with steam heat and some with connecting baths up to spacious modern bungalows, justified to keep top scientists and their families happy. Surrounding towns were scoured for living quarters of all types. The Federal Housing Administration sponsored new housing in war-crowded communities and trailer camps were built on the area and mushroomed of themselves in the nearby territory.

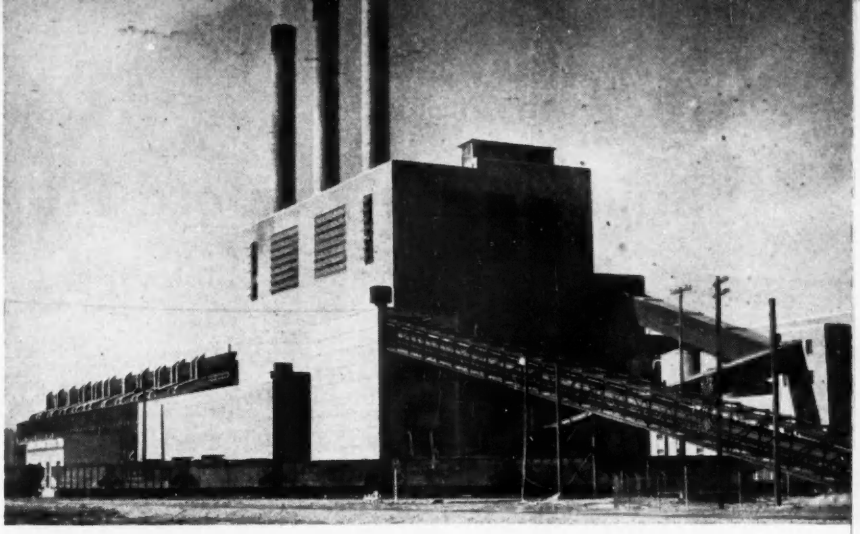
Panels of local rationing boards were established to help workers get gasoline and tires for "share-the-ride" clubs. A bus transportation system, which grew to one of the largest in the nation, was established to move workers to and around the work areas.

Nursery schools were established so that mothers would be able to take jobs. The Selective Service even deferred some laborers when they were essential to Clinton Engineer Works construction.

Safely emphasized

Clinton Engineer Works is justly proud of its safety record, achieved by wholehearted cooperation of all concerned, despite the accent on speed. At the end of August, 1945, after the expenditure of 218,000,000 man-hours on construction, the cumulative frequency rate (disabling injuries per million man-hours) was only 6.91 and the severity rate (days lost per thousand man-hours) was only 1.51. For comparison, the U. S. Department of Labor's national construction industry averages for the year 1944 were 27.70 and 3.68.

In addition, less than 0.06 percent of the total man-hours worked at Clinton Engineer Works were lost through labor disputes. Truly this is an achievement worthy of note, reflecting the cooperation of labor and satisfaction with efforts made to provide good working and living conditions.



Largest steam plant ever constructed in one operation supplies 238,000 kw. of power and process steam for Clinton Engineer Works. Black building at left is thermal diffusion plant.

The Clinton Engineer Works is a part of the "Manhattan Project" which is under the supervision of Maj. Gen. Leslie R. Groves. The Manhattan District of the Corps of Engineers is headed by Col. Kenneth D. Nichols, with the writer as his executive officer. Construction at CEW was started by Lt. Col. Warren George of St. Louis, Mo., continued under the direction of Col. Robert C. Blair of Urbana, Ill., Col. Thomas T. Crenshaw, of Watertown, N. Y. and Col. John S. Hodgson of Montgomery, Ala., successively. Through lack of space, credit cannot be given to all who had responsible positions on the project, but the accompanying partial list of outstanding executives is offered with the hope that readers will bear in mind that without the cooperation of thousands of others none could have accomplished his assignment.

TOP CONSTRUCTION PERSONNEL

Plutonium Pilot Plant

Contractor	E. I. duPont de Nemours & Co.
Project Manager	J. D. Wilson
Officer in Charge	Capt. James F. Grafton

Electromagnetic Plant

Contractor	Stone & Webster Engineering Corp.
Project Managers	T. C. Williams Frank R. Creedon T. R. Thornburg
Officers in Charge	Lt. Col. Warren George Lt. Col. W. E. Kelley Colonel John S. Hodgson Lt. Col. Mark C. Fox

Gaseous Diffusion Plant

Contractor	J. A. Jones Construction Co.
Project Manager	Edwin L. Jones
Officers in Charge	Colonel Walter J. Williams Lt. Col. William P. Cornelius

Conditioning Plant

Contractor	Ford, Bacon & Davis, Inc.
Project Manager	C. C. Whittlesey
Officer in Charge	Lt. Col. Curtis A. Nelson

Thermal Diffusion Plant

Contractor	H. K. Ferguson Co.
Project Manager	C. W. Roberts
Officers in Charge	Lt. Col. M. Fox Maj. T. J. Evans

Building the Hanford Plutonium Plant

Col. F. T. Matthias
Area Engineer, Hanford Engineer Works

● **The plutonium production plant at Hanford, Wash., was put in production in little more than a year in a "sagebrush and sand" area selected largely because it had good cooling water from the Columbia River and available electric power from the Bonneville Power Administration. Construction camps were provided for 40,000 workers and a permanent town for 17,000 operators and their families. Unusual concrete and steel structures were built to confine radiation. Gravel and sand aggregates were dug and processed at the plant site; concrete was mixed in central plants and delivered chiefly by pumps to construction areas.**

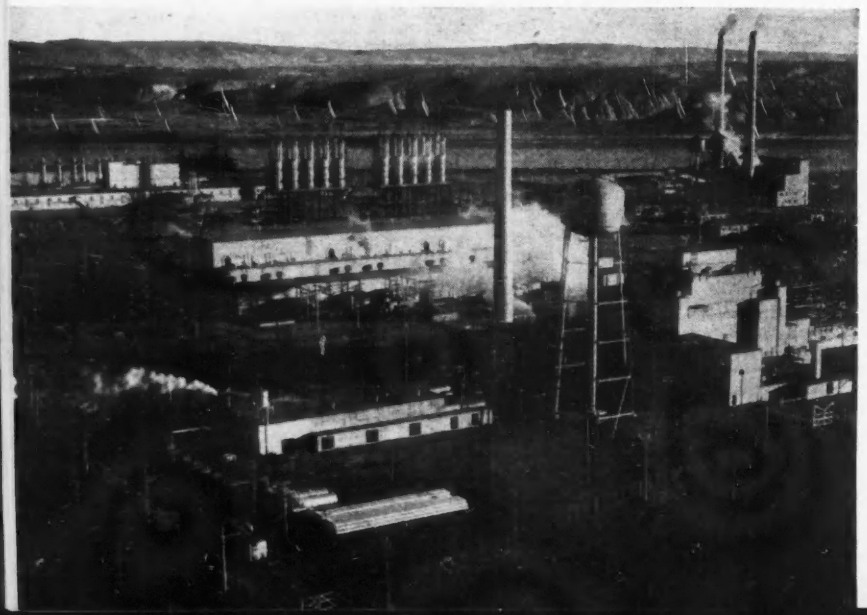
THE HANFORD Engineer Works, located along the Columbia River in eastern Washington, is one of the three major plants under the Manhattan Engineer District, built and operated for the production of the atomic bomb. The plant is devoted entirely to the production of plutonium atoms, using U-238 as the raw material and U-235 as the energy source for what is probably the world's greatest atom-making factory.

The project, as completed, includes seven major manufacturing areas, an operating village and administrative headquarters as well as all of the service facilities required for manufacturing processes in an area more than 600 sq. mi. in extent. The actual production units at Hanford are several huge uranium "piles." Each pile is a very large block of graphite with holes in which are placed uranium-metal cylinders, sealed in aluminum cans to protect the uranium from corrosion by the cooling water constantly pumped through the pile.

Work was begun on the first of the Hanford production piles on June 7, 1943, and operation of the first pile began in September, 1944, followed, during the fall of 1944 and the early months of 1945 by the second and third piles. The site was originally laid out for five piles, but construction of only three has been undertaken.

Besides the piles, there are plutonium separation plants, pumping stations and water treatment plants. There is also a low-power chain reacting pile for material testing. Not only are the piles themselves widely spaced for safety and mutual protection, but the separation plants are well away from the piles and from each other. The administrative and living quarters are situated many miles from all process areas.

One of seven major plant areas at Hanford for production of plutonium, using Uranium 238 as the raw material.



Utilities were a major project

With 158 mile of railway, 386 miles of highway, 52 miles of 230 kv. transmission lines, a water distribution system ranking in magnitude with the large metropolitan areas, construction housing for 40,000 and a village for 5,500 operating employees, and their families, the Hanford Engineer Works presented a large and difficult construction program, even without the seven complicated and massive plant structures whose construction and operation made the rest of the facilities necessary.

The plant was designed, constructed, and is now being operated by E. I. duPont de Nemours & Co., under contract with the Corps of Engineers for a total fee of $1. The prime contractor assumed general supervision of all construction, but wherever practicable subcontracted the work to utilize the administrative forces and the know-how of as many contracting firms as possible. Wherever plans and specifications could be prepared, work was done on a lump-sum or unit-price basis, but some necessarily was done under fixed-fee contracts.

The thing that has made construc-

tion at Hanford different is radiation from the breakdown of atomic nuclei generated within a pile operating at high power level, which is so strong as to make it quite impossible or at least seriously hazardous to permit any of the operating personnel to be exposed to its direct action. The whole of a power pile, therefore, had to be inclosed in very thick walls of concrete, steel or other absorbing material. At the same time it had to be possible to load and unload the piles through these shields and to carry the water in and out. Moreover, the shields must not only be radiation-tight but gas-tight since air or other gases exposed to the radiation in the pile would become radioactive.

Water needs tremendous

The water mentioned is needed to dissipate the thousands of kilowatts of energy, in the form of heat, generated in each producing pile. Requirements for this are comparable to that for a moderate-sized city, and pumping stations, filtration and treatment plants had to be provided. Furthermore, the system had to be a very reliable one; it was necessary to provide fast-operating controls to shut down the chain-reacting units in a hurry in case of failure of the water supply.

Radiation dangers that require shielding in the piles continue through a large part of the separation plant. Since the fission products associated with the production of plutonium are highly radioactive, uranium, after ejection from the pile must be handled by remote control from behind shielding, and must be shielded during transportation to the separation plant, where the "slugs" must be processed by remote control in shielded compartments. The general scheme followed was to build a "canyon" consisting of a series of compartments with heavy concrete walls arranged in a line and almost completely buried in the ground.

Ideal site for project

The site selected for this construction had several desirable characteristics:

1. The Columbia River, flowing through the site, is probably unequalled for purity and cleanliness as a source for the large supply of water needed.

2. Transmission lines of the Bonneville Power Administration crossed one corner of the area and provided convenient and easy access to a large, dependable power source.

3. Unlimited deposits of gravel proved a good source of aggregate.

4. Rainfall in the area is less than 6 in. annually, and mud, which so often immobilizes construction activities, is almost unheard of.

5. The climate, while it has extremes of heat and cold, is generally mild in winter and does not seriously hamper construction.

6. Only a narrow, irrigated area along the river was tilled and, considering the size of the site, its procurement and development displaced only a small number of people and put very little agricultural land out of production.

Hanford camp administrative center (top). The construction administration building is in the foreground and the hospital is at the right center. Women's barracks are at the far right and mens' at the left center. Portable "Pacific Huts" (below) were used for the last increment of housing, 900 ten-man huts being made to accommodate 10,000 men.

The job of construction was the equivalent of seven major industrial plants, and cost $350,000,000. Some idea of its magnitude is conveyed by the following partial list of standard construction equipment used at Hanford:

Road vehicles including sedans, station wagons, carryalls, panel trucks, pickup trucks, jeeps and other types of military cars totaled 1,800. Some 900 buses were used during the peak of construction, with a total seating capacity of 30,300. There were roughly 1,900 dump and flat-bed trucks; 437 crawler tractors; 240 tractor and trailer units; 147 transit-mix trucks; 29 fire trucks and 20 ambulances; 9 small portable batch plants and bin setups, excluding the main concrete mixing plants; 44 rail-

Many a hotly contested baseball game was played on this diamond at Hanford. The principal league series included teams representing the different construction crafts. These games and other athletic events occupied the spare time of thousands of workers.

road locomotives and 460 railroad cars including flat, gondola, bottom-dump and hopper-bottom types; 311 crawler cranes; 5 locomotive cranes; and 4 stiff-leg derricks.

Earth moving was a big job

Another measure of magnitude is by quantities of earth and concrete handled. For example, some 25,000,000 cu. yd. of earth was moved in connection with the construction of the principal building, 386 miles of highways and 158 miles of railroads. All of this work was done by subcontractors, and except for the large volumes involved was not difficult since the soil could readily be handled by scrapers and draglines supplemented by power shovels for trimming excavations for buildings.

It was originally estimated that well over a million yards of concrete would be required, but as design progressed this figure was reduced, and a total of 780,000 cu.yd. of concrete was actually placed, mostly in six buildings, requiring over 100,000 cu.yd. each.

Aggregate production and furnishing concrete were included in a single subcontract. The subcontractor erected two aggregate production plants; one near Hanford at the east and one near Haven at the west of the project area. Both were over extensive gravel beds and were conveniently close to the existing railroad. The Hanford plant produced 500 to 600 tons per hr. and the Haven plant 350 to 450 tons per hr., each providing three sizes of coarse aggregate and two of sand. The plants were located near the Columbia River and screening was done wet, with the sand separated wet in screw classifiers.

Material from each pit was delivered first by bulldozer and later by wheel scraper to hoppers in the pits that fed a belt conveyor carrying material to classifying screens. All material handling through the aggregate plant was by belt conveyor, and with classified material stored radially. Live storage at each plant was about 60,000 tons. Material was reclaimed from storage by belt conveyors operating in tunnels under each pile of stock material and loading into elevated hoppers that fed directly into railroad cars or trucks. The contractor elected to operate the two plants alternately at full capacity rather than simultaneously, and built a considerable stock pile at each of the plants in advance of active concrete operations.

All concrete plants different

Five concrete mixing plants were obtained by the subcontractor, and they were used in six locations, one of the plants being used twice. Of the five plants, three had two 2-cu.yd. tilting mixers, giving a capacity of 150 cu.yd. per hr., and two had two 3-cu.yd. mixers giving a capacity of 200 cu.yd. per hr.

The mixing plants were second hand and each came from a different job so there was no uniformity in the batching methods. One plant was completely automatic in its control of batch quantities and mixing time and was manually operated through a push button control system.

Cement handling facilities

At each mixing plant setup cement handling facilities included live baching storage of from 400 to 600 bbl. At two areas an additional 3,000-bbl. silo was erected to permit immediate unloading of railroad car deliveries. Unloading arrangements were provided to accommodate either hopper-bottom or box cars. Cement was elevated into the mixing plant bins or into the silos by means of a bucket elevator. Aggregate was delivered to the plants by belt conveyors feeding from under-track hoppers into which the five classes of aggregate and sand were delivered by railroad car and, in some cases, by truck.

Each concrete plant was equipped with a belt conveyor that fed mixed concrete into hoppers of concrete pumps delivering through pipelines to the points of placement. Each plant also was equipped with a hopper and delivery chute to batch materials into transit-mix trucks for mixing while hauling to isolated locations where only small volumes of concrete were required.

The prime contractor operated the transit-mix trucks and the concrete pumps and also handled the 7-in. distribution pipe lines. Although this is perhaps the largest amount of concrete ever placed under such a dual arrangement, close and effective coordination of the two organizations resulted in an efficient and smooth operation that was outstandingly successful.

Practically all of the concrete placing on the project was for building construction, with only a small part of it in mass sections. Much of it had to be placed in confined spaces and with small clearances. In all of these locations the concrete was thoroughly vibrated into position with pneumatic or electric vibrators, with careful attention given to vibrating methods and the vibrating time to assure dense concrete to avoid radiation leaks as well as to assume structural adequacy. Even in the mass concrete sections the reinforcing steel required made clearances small and complete compaction difficult.

A difficult concreting problem

Typical of the problems successfully met was concreting a roof section of a building with no intermediate support between walls 60 ft. apart. Special travelling forms were built, similar in principle to those used for tunnel lining. They were moved on the crane tracks installed near the top of the building walls for permanent use. The form assembly was jacked up to position, concrete placed and after it had hardened, the jacks were released to lower the forms for moving to the next bay. These forms were moved along the top of the building until the 3-ft. thick top slab was completed along the entire 800-ft. length. Three buildings of this type were built, the same set of forms serving for all of the structures.

Many construction materials and some steel shapes had to be fabricated on the job. The prime contractor set up a shop for the fabrication of some very large T-beams of heavy steel sections, roughly 4 ft. x 4 ft., and all the material for all of the areas involved was assembled and prefabricated for erection at this shop.

Concrete pipe made on the job

Subcontracts were let for the extensive water distribution system. The sub-contractor providing the concrete pipe elected to manufacture the pipe on the site, which was accomplished by spinning concrete onto hoop reinforcing and curing the finished pipe in steam. A number of buildings in the plant were built with steel framing and concrete block, and this block was also fabricated on the site under a sub-contract.

Where it seemed desirable, central shop facilities were set up to prefabricate and prefit materials that had to go into the process buildings. This served the double purpose of concentrating skilled workmen on this duty and of speeding up the completion of the buildings by eliminating field fitting. The latter was a particularly important requirement as the tolerances for a substantial volume of the construction was on the order of ±.003 in., equivalent to precision machine shop work. Much of the large and heavy equipment also had to be rigged and fitted to similar tolerances to permit remote control installation and removal.

A common construction problem that was unusually difficult to overcome at Hanford was servicing and maintenance of equipment. Practically all of the construction machines used were acquired from surplus stock at other Corps of Engineer projects that were being completed. These machines were of every make, size and type, making the job of servicing and maintaining stocks of repair parts very complicated. Also, getting and keeping mechanics who were capable of handling such diversified repairs and maintenance was a problem in itself.

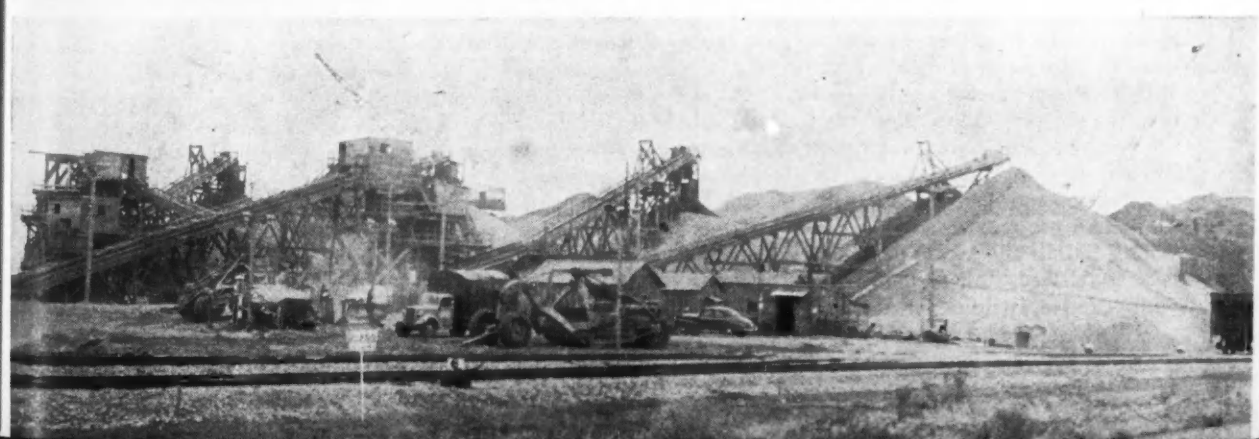
An area near the "center of gravity" of the construction project was selected as the site for the central repair shops.

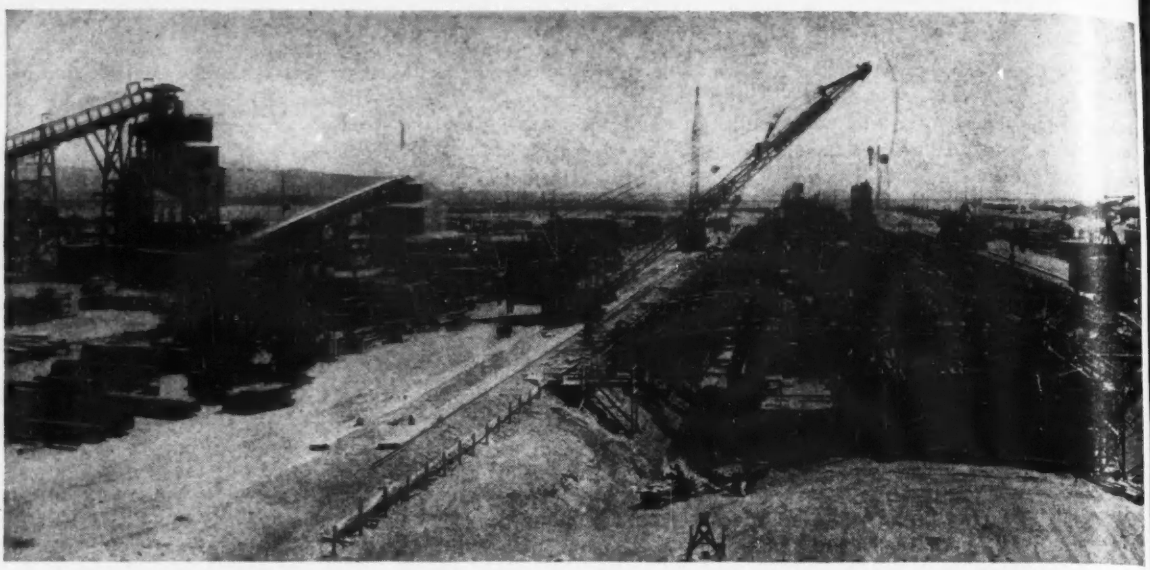
In addition, to prevent so far as possible the need for repairs, 270 grease and fuel trucks were used on field inspections and for servicing vehicles and equipment. Automotive equipment was checked periodically, as well as after designated lengths of service. For example, dump trucks were serviced every 250 miles or every three days, whichever occurred first; flat trucks every 500 miles or every five days; pickup trucks every 750 miles or every ten days; sedans, station wagons etc., every 1,000 miles or every 15 days.

Heavy equipment maintenance

The heavy equipment lubrication program involved oil changing and air and oil filter changes and greasing, all of which were set up on separate schedules. Tractors, motor patrols and other items of heavy construction equipment were greased at the close of each shift. Oil changes were made every 56 hr. of operation. Other types of equipment, such as

Aggregate production plant at the west end of the project. Natural aggregates occurred in proportions closely balanced to the concrete requirements.





Forms in place ready for concrete in the substructure of one of the massive buildings. Concrete was delivered by pipeline from mixer plant and pump building at left. Forms were built in panels and reused for other similar structures.

welding machines, light plants, air compressors and pumps, were greased periodically as determined by their gasoline consumption.

The labor force for construction at Hanford reached a peak of 45,000, for most of which it was necessary to provide living quarters. Some found existing accommodations in the surrounding area, and the Public Roads Administration and the Washington Department of Highways cooperated to improve roads around the area to increase the travel radius. But there were not adequate living facilities in the sparsely settled area, and a major construction camp, equivalent to an army cantonment, had to be built to meet housing demands.

Housing for 39,000 persons

A single camp was decided upon as offering much more in the way of flexibility and efficiency than would establishment of separate camps at each of the major production areas. The unincorporated village of Hanford (1940 population 436) located about six miles from the nearest plant unit, 25 miles north of Richland and 40 miles from Pasco passenger railhead for the project, was selected as the camp site. The area was almost flat with a slight grade toward the river, thus permitting drainage without pumping to near the river, where settling basins and treatment works were established. All of the central administrative facilities for the construction of the project were established at Hanford.

First housing was barracks for men, buildings 30x130 ft. set up in groups of four, with a common bathhouse for each group. Buildings were of light frame construction with a wallboard exterior and were partitioned into rooms for two men each with a general lounge room, which later was modified to permit additional housing. A total of 131 such barracks was built to provide space for 24,000 men.

Barracks for 5,000 women

Similar barracks were built for women, except that the rooms were slightly larger and only two buildings were connected to a common bath and laundry. Here again the original lounge room was later utilized for dormitory space to accommodate the peak of construction population, which included some 5,000 women.

Later, 900 huts, 16x40 ft. in plan, of arch type, plywood portable units used in war theaters, were purchased and erected at the camp. Each of these huts housed ten men, and a group of 20 huts was served by one toilet and bathhouse. During the peak of construction, these buildings also were crowded; at one time almost 10,000 men were housed in the 900 arch-type huts. Thus, a total of 39,000 individuals were housed at the peak of construction.

On the large construction jobs in the West in recent years, many construction workmen have learned to provide their own housing in the forms of privately-owned trailers. In line with this practice, a large trailer area was laid out at Hanford with a definite space for each unit and a central bathhouse and laundry provided for each group of about 30 trailers. Water connections were furnished for each trailer and a light frame shed with a paper cover was erected to give protection from the sun during the hot and dry summer period.

Trailers were also popular

The trailer camp at its peak accommodated 4,300 privately owned units. The peak of trailer housing at the Hanford camp, however, came several months after the peak of the employment as the trailer camp occupancy was building up even while other housing was being vacated.

Studies as to attendance, turnover and length of time on the job indicated that the workers in the trailer camps were by far the most contented group at Hanford, were contributing less to absenteeism and appeared to be doing the most efficient productive work. People in the trailer camps took great pride in the neat appearance of the area and developed a civic interest that resulted in quick establishment of all activities of a normal community.

An entirely separate city, in the

Richland area, was built to house operators of the production plants. Here, some 2,500 conventional type house units, 45 dormitories, store and commercial facilities, churches and schools, were constructed, almost all of the wood-frame type. Many parts of this construction were preassembled with millwork fabricated at a plant erected on the site.

In addition to the 2,500 conventional houses, about 1,800 prefabricated houses were erected. These "prefabs" were assembled at a mill some 300 miles from the site and were brought in on trucks and erected on prepared foundations. Streets, walks, playgrounds and all utilities were constructed to provide for normal small city needs.

Housing at Richland was subcontracted, with the prime contractor performing the administrative and control work as well as inspection. This subcontractor for the village handled practically all of the specialty work by sub-subcontract, requiring extensive coordination of all types of activities in the Richland area.

With construction areas four to eight miles apart, the "center of gravity" of construction areas some ten miles from the construction camp, with one major construction job located about 20 miles from the center of gravity and the village of Richland about 25 miles from the main group, the problem of central control of construction operations was exceedingly complex. The entire operation was administered from Hanford headquarters with most service functions centralized in one office to insure maximum benefits to all plant areas.

DuPont construction organization

The construction division of du Pont was organized with a field project manager in charge, while assistant field project managers and a field superintendent headed up each of the various phases of the work such as control, service and engineering. Planning and scheduling of work was under the direct supervision of the field superintendent who reported to an assistant field project manager in charge of control. Actual prosecution of work in the field was under the supervision of craft superintendents who reported to the field superintendent. Inspection was directed by an assistant field project manager in charge of engineering.

Moving men and materials

Moving of men and materials was under the control of a transportation superintendent who reported to the field superintendent. All material came into a central receiving station, was requisitioned by the various areas and delivered by the transportation department.

Men were dispatched to various areas from the construction camp under the supervision of the field superintendent. By this means the assignment of men of various crafts to work in the areas where they were needed most could be coordinated for the entire job, with men drawn from the Hanford construction camp to meet each area's requirements. Actual job control in the field was handled by breaking down every item of work involved in the construction of an area, making up estimates of manpower requirements, scheduling each item of work and assigning it to the

Richland, the operating headquarters and housing area for project employees, was built on the site of the former village of Richland. The administrative area is in the center of the picture. The low land beyond the administration area was below maximum flood stage of the Columbia River and was not used for building sites.

proper craft superintendent for accomplishment on a coordinated craft basis.

All of the construction facilities at the Hanford camp were under the control of a service superintendent who handled housing and feeding, commercial leases and other matters pertaining to that area. The actual camp services were performed by a subcontractor who reported to the prime contractor. These included rental and collection of rents for barracks rooms, feeding and administration of the camp. About 25,000,000 meals and box lunches were prepared and served by the housing and feeding subcontractor during the construction program.

Safety made to pay

Through all phases of the construction operation considerable attention was given to safety and morale maintenance activities. Every effort was made to educate workmen in safe practices and to avoid carelessness in all of their activities. No one was allowed in the building construction areas without a safety hat. To help induce the employees to wear safety clothing, a trailer was fitted as a store and taken to convenient points to sell safety shoes and gloves.

Men who performed their work according to safe methods earned individual safety awards. These were made on the recommendations of the supervisors, and were based on daily observation of safe work practices over various periods of time and for special contributions to safety. Safety meetings were held frequently.

A safety engineer in the contractor's organization exercised his influence through officials in various supervisory positions. The project made an enviable safety record with ratings, based on the National Safety Council system of an accident frequency of 5.99 percent and an accident severity of 1.30 percent. Sixteen fatalities occurred, eleven as a result of two serious accidents.

Leisure time opportunities

Security surrounding the project made it difficult to impress on the workers the importance of the job and to glamorize the part they were playing in the war. As an alternative it was determined that the most effective way to keep people at the project was to make off-hours living easy and enjoyable with opportunities for education and recreation. Recreational facilities were established in the construction camp to perhaps a greater extent than has before been done on a construction project.

Foremen were urged to watch their men and be sure that none was being kept on work for which he was not suited. Also, information services were established in the personnel department of the prime contractor where employees could get help and counsel on any problems that might be bothering them.

For the Corps of Engineers Maj. Gen. Leslie R. Groves was responsible for the project as part of the Manhattan Engineer District program that was under the direct control of Col. Kenneth D. Nichols, district engineer. The writer was area engineer, contracting officer and commanding officer on the project.

BUILDERS OF THE HANFORD ENGINEER WORKS

PRINCIPAL CONSTRUCTION SUBCONTRACTORS

Firm	Home Office	Class of Work
Smith, Hoffman & Wright	Portland, Ore.	Housing
Hanford Concrete Contractors	Winona, Minn.	Ready-mix concrete
Myers Bros.-N. M. Ball & Sons	Los Angeles	Excav. & Road Const.
Morrison-Bechtel-McCone	Boise, Idaho	Composite tanks
Twaits-Morrison-Knudsen	Los Angeles	Housing & utilities
Guy F. Atkinson Co.	San Francisco	Channel excav. & R. R.
Guerin Bros.	San Francisco	Excav. road & R.R. Const.
Clinton Bridge Works	Clinton, Iowa	Structural steel
*Olympic Commissary Co.	Chicago	Commissary operations
*Newberry-Chandler-Lord	Los Angeles	Electrical work
*Hankee-James-Zahniser & Warren	St. Paul	Piping work
G. A. Pehrson	Spokane, Wash.	Arch.-Engr. services
A. A. Durand & Son	Walla Walla, Wash.	Drilling of wells
American Pipe & Constr. Co.	Los Angeles	Reinforced concrete pipe
National Gunite Contracting Co.	Washington	Gunite reservoirs
Erie City Iron Works	Erie, Pa.	Boilers
Combustion Engr. Co.	New York	Boilers
Chicago Bridge & Iron Co.	Chicago	Elevated steel tanks
Link-Belt Co.	Philadelphia	Coal handling systems
Rush Engineering Co.	Pittsburgh	200-ft. chimneys

** Cost-plus-fixed-fee contracts. All others lump-sum or fixed price.*

TOP DU PONT CONSTRUCTION MEN

E. G. Ackart	Chief Engineer
G. M. Reid	Assistant Chief Engineer
M. F. Wood	General Manager Constr. Div.
F. H. Mackie	Manager, War Construction
T. W. Brown	Chief Accounting Officer
G. P. Church	Field Project Manager
T. L. Pierce	Asst. Field Project Manager
G. E. Bubb	Asst. Field Project Manager (Construction)
W. V. Krewatch	Asst. Field Project Manager (Engineering)
G. E. Hillman	Asst. Field Project Manager (Control)
L. S. Grogan	Field Superintendent
E. L. Pleninger	Service Superintendent
B. M. Taylor	Housing Superintendent

PRINCIPAL CORPS OF ENGINEER OFFICERS

Col. Franklin T. Matthias	Area Engineer
Lt. Col. Harry R. Kadlec	Chief, Construction Division (deceased)
Lt. Col. Benjamin T. Rogers	Chief, Construction Division
Maj. Richard F. Ebbs	Executive Officer (during construction)
Maj. Harry D. Riley	Chief Engineering and Services
Maj. Joseph F. Sally	Chief of Operations
Maj. William L. Sapper	Area Eng., Wilmington, Del. Office
Maj. Frank P. Erichsen	Pile Area Construction

Photo by Thompson, Knoxville

A section of the electromagnetic process plant at Clinton Engineer Works built by Stone & Webster Engineering Corp.

Men and Materials for a $427,000,000 Job

Stone & Webster assembled what is probably the most diversified engineering and construction organization ever to work on a single project when they built the electromagnetic plant and the city of Oak Ridge. The problems of procurement and handling of materials were often unique and always difficult of solution. How this was handled constitutes an important chapter in the story of production of the atomic bomb.

A GIGANTIC PLANT consisting of 175 separate buildings, including nine major processing structures, was constructed at the Clinton Engineer Works for electromagnetic separation of the isotopes of uranium. This plant and living facilities at nearby Oak Ridge were constructed by Stone & Webster Engineering Corp. under what is believed to be the largest design and construction contract ever awarded to a single firm. First and all-important in developing the design for the electromagnetic process as well as in building the plants and the City of Oak Ridge, was procurement and assignment of personnel. Coupled with this was the purchasing, expediting and handling of the necessary materials.

A brief statement of just what is accomplished by the plant helps in an appreciation of its complexity and size. Its purpose is to separate U-235 from U-238 (which is found in nature in a ratio of 1 to 140) by forcing a stream of molecules at high speed through the field of a powerful magnet. The lighter U-235 particles form a curve of shorter radius than the curve formed by the U-238 particles, and by catching in different containers the isotopes thus partially separated, U-235 of high purity can be produced.

The ionized particles to be separated must travel in a very high vacuum or they will be deflected by collisions with molecules of air. To provide almost a perfect vacuum, pumps of much higher speed and lower pressure than were ever previously developed for commercial purposes are required. Extremely accurate control equipment for the high voltage current is necessary to maintain constant conditions in the magnetic field, for if this varies, the curvature of the streams of particles will vary and the entire operation will be futile.

Procurement and assembly of this unprecedented equipment, as well as design and construction of the unusual buildings to house it, and utilities to connect and service it were handled by the Stone & Webster Engineering Corp. as engineers and constructors. Basic process design was formulated by scientists at the Radiation Laboratories at the University of California, with whom Stone & Webster men worked to translate ideas into the production plant. The continuing job of operation is done by the Tennessee Eastman Corp., which collaborated with Stone & Webster to check and perfect the design. Problems on specialized equipment were worked out jointly with Allis-Chalmers Co., Westinghouse Corp., General Electric Co. and many other manufacturers.

Work supervised or done directly by Stone & Webster's own forces has a total value of $427,000,000, including the purchase of equipment for the plant and construction of most of the city of Oak Ridge, which had a peak population of nearly 75,000.

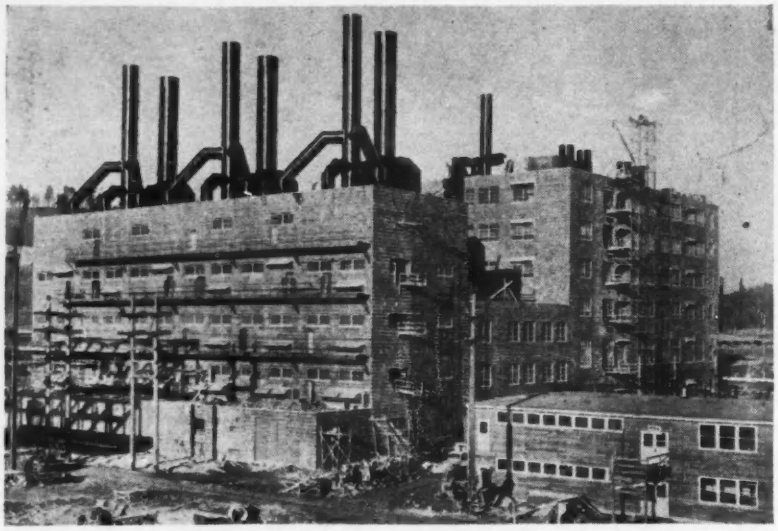
This article was prepared through the cooperative effort of several top men of Stone & Webster Engineering Corp.

T. R. Thornburg, project manager
T. W. Piper, personnel manager
R. R. Wisner, assist. project manager
T. J. Forde, contract manager
J. P. Piper, purchasing manager
G. P. Darlington, expeditor
E. P. O'Connor, field accountant
H. I. Castlebrook, engineer

Secrecy paramount

Plant construction, and to some extent even the housing, was accomplished under the handicaps of a remarkably successful secrecy control.

This control made it necessary to set up an independent engineering organization with representation at several locations to cover direct contact with the physicists, chemists, operators and constructors at the job site, with only a selected few having complete knowledge of what was to be accomplished. Upon these few was placed the responsibility of coordinating the parcelled-out portions of



Chemistry building has tile enclosing walls and wood frame windows. Chicago boom on materials tower at right aided in bringing up equipment too large for handling inside the tower cage.

the work. Many thousands of drawings had to be provided so that the workmen in the field and in the factories could produce the component parts and subassemblies without gaining a clue as to the end product.

In spite of security restrictions and shortages of materials and manpower, there was completed within a three-year period a program for development and production that, in peacetime, would easily require 10 to 15 years. The urgency was so great that small scale laboratory developments were expanded directly into a gigantic production unit operated by personnel secured from all walks of life and with no previous similar training. Actually, the electromagnetic plant was the first unit to produce suitable quantities of the usuable product, and for nearly a year was the only plant in production.

Personnel was major problem

While the site of Clinton Engineer Works was still sparsely inhabited farmland a separate office of Stone & Webster was established in Boston for design, purchasing of material and equipment and expediting of delivery for some of the experimental works as well as for the major plants then contemplated. This and offices subsequently established at the Clinton Works and elsewhere were manned by a nucleus of experienced Stone & Webster employees.

By the time the project got under way, in November 1942, serious manpower shortages existed in all classifications so that the first step was to call conferences with representatives of labor organizations, the U. S. Employment Service, and the War Manpower Commission, at which scheduled requirements were discussed and the secrecy and urgency of the project outlined in enough detail to emphasize its importance.

WORK PERFORMED BY OR UNDER SUPERVISION OF STONE & WEBSTER ENGINEERING CORP.

General	
Excavation	7,200,000 cu. yd.
Roads	200 mi.
Sidewalks	225 mi.
Railroads	36 mi.
Sewer & water lines	550 mi.
Crushed stone	2,800,000 tons
Electric distrib. systems	160 mi.
Concrete	400,000 cu. yd.
Electromagnetic plant area	
Buildings	175
Floor area	4,500,000 sq. ft.
Cubic content	85,000,000 cu. ft.
Townsite and facilities	
Dwellings	7,843
Stores and misc. bldgs.	86
Dormitories, barracks	97
Hutments	1,325
Trailers	3,310
Warehouses	51
River pump house	28.0 mgd.
Filtration plant	15.75 mdg.
Sewage disposal plants	5.5 mgd.
Four reservoirs	10.5 mg.
Employment	
Av. of employees	18,000 per day
Peak of employees	28,000 per day
Manhours worked	105,000,000 hrs.

Recruiters were employed and stationed in the larger labor centers throughout the southeast. Those interviewed who met preliminary qualifications and were willing to accept a job were given transportation to the project for final inspection and classification. Each person employed was carefully investigated not only as to construction and technical experience but as to past history, loyalty, habits, citizenship and other characteristics, and each was required to sign a secrecy agreement. Requisitions for needed employees were submitted by each division superintendent and channeled through the project manager's office where an overall program was compiled and transmitted to the personnel manager for fulfilment.

Some idea of the magnitude of this undertaking can be obtained from the fact that in the period from Nov. 1942, the start of the project, to Sept. 1943, the number of persons employed by the Stone & Webster organization on the project increased to a peak of 28,000, and continued at that level for a period of eight months. The average number of employees up to the present time has been 18,000. To obtain this number, it was necessary to interview nearly 400,000 people, of whom about one out of three was hired.

Difficult living conditions

Like all construction jobs, mud, dust, and lack of housing made working and living conditions difficult at the start. Even greater effort was necessary to hold personnel than to get it.

In general, housing for construction workers was provided in several types of low-cost temporary units: (1) hutment camps, separated for white and colored and for laborers and craftsmen; (2) trailer camps, some utilizing government-owned units and some providing simply sanitary, lighting and road facilities for private trailer use; (3) small family huts for supervisors; (4) dormitories; and (5) a few houses in the townsite for department heads and administrative personnel.

Those employed to operate the atomic plants were given priority over construction workers on housing in the town site, and most of the latter had to commute from surrounding communities, a few from as much as 90 miles away.

Most of the work was done on a 10-hr. day-shift, but some second shift work was carried on to make greater use of heavy equipment and to bring special rush units up to schedule.

Naturally one would expect some labor unrest on a project of this magnitude and urgency. However, competent men in the Stone & Webster organization were in constant touch with union stewards, and were able to anticipate and compromise or arbitrate all grievances. It is estimated that not more than 10,000 man-hours were lost due to jurisdictional disputes or work stoppage, compared with the total of 105,000,000 man-hours worked.

Materials for the job

Purchasing $260,000,000 worth of major materials on a war-scarce market without telling vendors why items were needed in a rush was in itself no small feat. Secrecy was stressed at all times and the individuals working in this department and the manufacturers with whom orders were placed were completely unaware of the project's final object.

Stone and Webster's connection with the atomic bomb project antedates establishment of the Clinton Engineer Works with activities at first confined largely to securing raw materials. This included arrangements for the purification and transformation of uranium ore into the forms required for the several experimental processes underway and the procurement of other raw materials such as carbon and beryllium with purchasing handled from the Boston office. An early activity was the purchase of materials and equipment for the plutonium pilot plant constructed near Chicago.

Later, when Stone & Webster was authorized to proceed with construction of the electromagnetic plant and the town of Oak Ridge, the purchasing emphasis was transferred to materials and equipment for that major project.

A separate purchasing department was established in the Boston office to handle procurement of technical equipment and materials designed by the engineering department, and a contract office was maintained for preparation of contracts and subcontracts for process equipment.

A similar contract office was established at Oak Ridge to handle construction contracts and subcontracts while a local purchasing department obtained construction equipment and materials. Coordination of purchasing activities was accomplished through the preparation of material schedules for each structure. The division of responsibility was made by the use of standard Stone & Webster forms listing the materials required and then assigning the responsibility for purchasing.

Contemplated extensions to the overall construction programs were known to executives and lists of steel, copper, alloy pipe, and other critical materials were prepared in advance of authorization to proceed with construction. These lists were forwarded to Washington and were discussed with War Production Board, with the result that orders for strategic materials invariably were placed within two days after authorization to proceed with construction. A considerable share of the credit for the excellent construction record is due to the unusually effective action of this procurement group.

In placing orders, full consideration always was given to the ability of manufacturers to make early deliveries. In certain instances, orders were intentionally divided among two or more vendors to obtain the advantage of the combined shop facilities. In general, orders were placed on an AA2X priority, which was sufficient to obtain most material and equipment. However, a liaison office of the Manhattan District in Washington, D. C. cleared rush matters with the War Production Board and, when necessary, arranged upratings to AAA, or directives to enable manufacturers to meet delivery dates.

Treasury annex

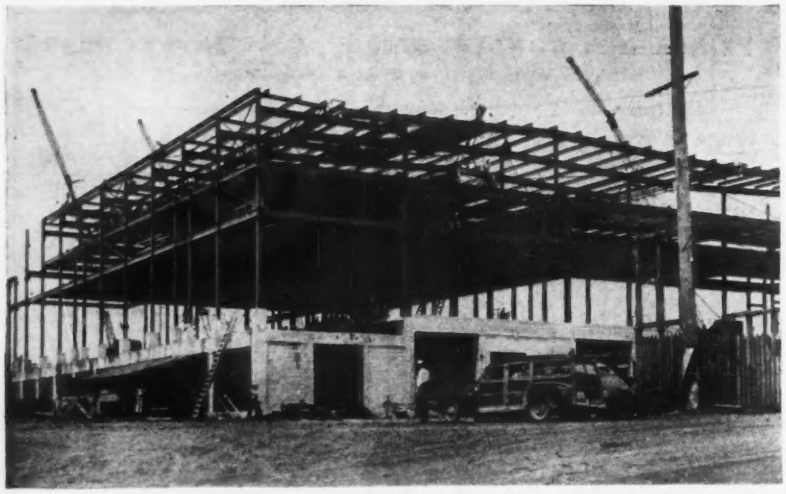
Procurement of equipment and materials for the project was handled through the media of contracts, subcontracts, purchase orders, and formal modifications thereto, involving a total commitment for the expenditure of $260,000,000. The largest individual purchase was a contract involving an expenditure of $17,500,000. Some 14,000 tons—$400,000,000 worth—of silver was borrowed from the U. S. Treasury for use as busbars and winding coils for the many magnets, taking the place of unavailable copper.

Thousands of vendors and manufacturers are numbered among the suppliers, and goods have come to Oak Ridge from nearly every state in the union. Awards for the secret process apparatus, however, were limited to a few producers, and each manufacturer was required to isolate the part of his plant used for the assembly. Purchase orders and subcontracts were made in the name of Stone & Webster Engineering Corp., while prime contracts were made in the name of the U. S. Government.

PRINCIPAL CONSTRUCTION SUBCONTRACTORS

WORKING WITH STONE & WEBSTER ENGINEERING CORP.

Firm	Home Office	Class of Work
John A. Johnson Company	New York, N. Y.	Townsite housing
Clinton Home Builders	Charlotte, N. C.	Townsite housing
O'Driscoll & Grove, Inc.	New York, N. Y.	Townsite housing
Harrison Construction Co.	Pittsburgh, Pa.	Grading and drainage
Foster & Creighton Company	Nashville, Tenn.	Townsite buildings
Ralph Rogers Company	Nashville, Tenn.	Crushed stone
Transit-Mix Concrete Corp.	New York, N. Y.	Concrete
A. Farnell Blair	Decautur, Ga.	Townsite buildings
D. W. Winkleman	Syracuse, N. Y.	Water and sewer
C. O. Struse & Company	Philadelphia	Masonry
Rock City Construction Co.	Nashville, Tenn.	Townsite buildings
Fluor Corporation	San Francisco	Cooling towers
Bethlehem Steel Company	Bethlehem, Pa.	Structural steel
Watson-Flagg Engineering Co.	New York, N. Y.	Electrical Work
Hanley & Company	Chicago	Pipe & equip. instl.
Rockwood Sprinkler Co.	Worcester, Mass.	Sprinkler systems
Tennessee Roofing Company	Knoxville, Tenn.	Roofing
Bristol Steel & Iron Works	Bristol, Va.-Tenn.	Structural steel
Drainage Contractors, Inc.	Detroit, Mich.	Water and sewer
Sullivan, Long & Haggerty	Bessemer, Ala.	Water and sewer



Concrete frames to second floor permitted start of building while steel was being fabricated. Designed for heavy load of electromagnetic process equipment the floor carries cranes setting the steel.

A force of 119 field inspector-expediters, 26 schedule men, 9 priority men and 85 field stenographers and clerks was utilized to inspect and keep material moving. The expediting office was located at Boston until April 1944 and since then has been at the project; in addition, branch offices were maintained in eleven principal manufacturing areas.

The job of the expediters was not to ask when needed equipment would be shipped. Instead, immediately after an order was placed, the manufacturer was contacted to determine that all information was at hand to start production. By following up suborders and material purchases using priority support, uprating of orders to AAA or directive and authorization of overtime, the quoted delivery dates of the manufacturer were accelerated in some cases as much as two or three months. At times, the inspection-expediting personnel had to find new sources of supply for hard-to-get items a prime contract holder required for manufacture. In some cases substitution could be arranged and frequently precious metals, loaned by the U. S. Treasury, were made available for use.

Some 80 percent of the $260,000,000 worth of material purchased required inspection prior to acceptance. This was handled by the inspection-expediting forces, often the same man performing both functions. In addition the same forces served as close liaison with the construction organization. They were able to step-up manufacture to meet speeded construction schedules and, fully as important, were in a position to advise that rush work on an item could be suspended in favor of some other rush job when the first could not immediately be used.

Handling the material

The receiving, warehousing and distribution of material and equipment necessary for the construction was a most difficult problem. Due to the scarcity of critical items and the unknown size of the ultimate development, it was considered essential that all material and equipment that might possibly be used be secured and kept on hand so as not to retard final completion.

Securing construction equipment was a major problem, met partly by obtaining over 5,000 pieces such as cranes, bulldozers, trucks, compressors and similar equipment from other government projects that either had been completed or closed down. In fact, Clinton Engineer Works became a central storage area for surplus materials of all types and description. As carloads arrived in unexpected numbers, the problem of distribution became a nightmare as the contents frequently were unsolicited and use for them unknown.

Much of the material received had to be stored in yards or in regional warehouses to be used when required, but a large portion could be checked at the central receiving station and then hauled to the planned point of use. A night crew was established for unloading and checking and, except for a very short period, no backlog of cars accumulated despite receiving 500 cars weekly of all kinds of material.

A systematized method of handling incoming material was developed for the process plant. At first, trucks transporting material and equipment from the central receiving depot went to an area receiving department where a man accompanied each truck to its ultimate destination and checked the material upon unloading.

As construction of warehouses progressed and railroads were brought into the areas, nearly all shipments were dispatched directly to the point of use or adjacent warehouses. In addition to general piping and electrical warehouses, a division warehouse was provided for each major process building and its appurtenant minor buildings. Subordinate warehouses were established within divisions for use of various departments. The vast quantity and variety of instruments required for the project, as well as their complexity made it necessary to provide separate warehouses for them.

Much "secret" equipment arrived in sealed cases, identifiable only by case number. Lists of equipment contained in the cases were secret and were not available to the material department. When a certain item of equipment was required, the number of the case containing the item was transmitted to the material department, and the case was brought directly to its destination. At no time was any secret equipment unpacked elsewhere than at the immediate place designated for its installation.

Concerted effort of many

Design of process and structures, the supplying of materials and the construction in the field for the electromagnetic plant, as well as other work on atomic bomb production handled by Stone & Webster was accomplished by the concerted effort of a much larger number of contributing firms and individual people than can be listed here. On this project, these subcontractors, materials suppliers and direct employees of Stone and Webster Engineering Corp. all over the country made outstanding contributions and all share, as they have served, in the achievement.

Process Buildings Over Faulted Rock

L. Kerr — Structural Engineer
P. Brown — Resident Engineer
Stone & Webster Engineering Corporation

● **Faulted rock, found under an important building foundation, was utilized for support of heavy units of the electromagnetic process of separation of uranium isotopes by an unusually heavy foundation slab. For a later building on similar rock, basement space was obtained at no extra cost by excavating the entire building area to the top of the limestone, then pouring a thick base slab. Buildings are concrete or steel frame.**

DIFFICULT FOUNDATION conditions were found to exist under some of the areas into which project expansion pushed the construction for the electromagnetic plant at Clinton Engineer Works. The plant, designed and built by Stone & Webster Engineering Corp., is located in a narrow valley with hills on each side to serve as protective barriers and isolate the process areas.

To expedite start of the project, layout and plans were made in Boston from aerial surveys, supplemented by some ground mapping of wooded areas. In general, these surveys were adequate but they were augmented as soon as locations of main buildings were known by comprehensive investigations made by core borings to determine conditions below the surface. These borings, and subsequent test pits and excavation for structures, disclosed that two fundamentally different classes of soil conditions existed in the valley.

On one side of a small drainage channel the underground formation is what is known as Conosauga shale. The top 2 to 5 ft. of the ground is medium to soft brown clay, resulting from the decomposition of the shale. Underlying this clay and extending for perhaps 5 ft., weathered shale in place is encountered.

This material contains clay seams, particularly in the upper portions, but the seams diminish rapidly in number and extent to a depth of not greater than 12 ft. The unweathered shale below that level forms an excellent and satisfactory foundation as it is virtually incompressible if protected from weathering during excavation and placing of concrete. Bearing conditions suitable for design loads of 12,000 psf. exist at depths of not more than 15 ft. and the structures planned

Limestone pinnacles and mud pockets were some of the difficulties encountered in foundations for the plant buildings.

Structures built in the early days of the project, when steel was especially critical, are all concrete frame. About 175 major structures were constructed by Stone & Webster for the electromagnetic process plant.

for this area were founded and built with no particular difficulty.

On the opposite side of the valley, however, soil conditions are entirely different. The underground formation, in general, consists of uptilted beds of dolomitic limestone of the Knox formation. These limestone beds are tilted away from the center of the valley at an angle of 55 deg. from the horizontal. Prehistoric streams eroded the uptilted beds into ridges running parallel to the strike between the limestone and the Conosauga shale. The crevices so formed vary in depth from a few inches to, in some places, 10 ft., and are filled with soft residual clays.

Boulders and pinnacles

In general, boulders of all sizes are found directly over or in the crevices of the limestone. Limestone pinnacles, ridges and boulders are encountered in the top 15 or 20 ft. of the ground surface. The shattered, uptilted beds of dolomitic limestone eroded by prehistoric streams and ground water that formed deep crevices in the limestone formation, together with boulders directly over the limestone surfaces, were most unsatisfactory for supporting heavy process buildings. As would be expected for a separation plant using giant magnets load concentrations are quite high, and permissible settlement is essentially zero.

The location of the first group of four main process buildings constructed was determined primarily to suit operating conditions and was over the shattered limestone. Core-boring holes made for subsurface investigation and supplemental holes to make a 15-ft. pattern each way were grouted in an attempt to fill cavities and crevices as well as to stabilize the limestone. About 1,100 cu. ft. of grout was pumped into 150 holes at pressures varying from 12 to 20 psi. The grout used varied in consistency from 3 to 6 gal. of water per bag of cement.

Over this grouted area, independent, soil-bearing, spread footings were adopted for the first three large buildings and, due to the restrictions on the use of steel, were of unreinforced concrete. A conservative bearing value, 15,000 psf., was used. Foundation conditions for the first process building did not offer any particular difficulties; the second and third buildings, although the conditions were much poorer, still could be constructed in accordance with the original designs.

Serious difficulty, however, was encountered in preparing the foundation for the fourth of the process buildings. When the overburden was removed, it was found that there was no solid rock as indicated by the core borings, but large, flat-topped and irregular boulders, some of which were 20 to 25 ft. in depth. These boulders, laid against and on top of each other, were usually so close together that the muck between could not be removed by mechanical means.

Heavy slab consolidates foundation

Here was real trouble, so serious that time and labor expended in attempting to excavate to suitable foundations only made conditions appear more hopeless. A new location was not logical from an economic or engineering standpoint. Construction of the other process buildings was well advanced, as well as that of a boiler house, chemistry group and other inter-related buildings. Therefore, after completing the general shovel excavation and hand cleaning, exposed limestone surfaces and crevices were given a thorough water flushing with fire hoses, and a solid mat of concrete was placed over a large portion of the building area. This mat was lapped over the ridges and large boulders in such a way as to tie the entire shattered limestone formation together.

Under the rest of the building, where underground conditions were not so bad, core holes were made and grouted as for the other process buildings. Unreinforced spread footings were constructed, resting directly on the mat that had been poured to hold

the limestone formation together or directly on the limestone in the area where grout had been forced to fill the cavities and crevices.

Once the extent of the undesirable subsurface condition was known it generally was possible to avoid locating structures over it. It was economical for other reasons, however, to locate another of the main process buildings over the shattered and creviced limestone.

Difficulty turned into asset

Now, however, fully cognizant of the substructure peculiarities a new plan was adopted. Instead of digging individual foundations, the broken-up surface material was removed and a heavily reinforced concrete foundation mat placed over the entire building area at a sufficient depth below the ground surface to obtain suitable bearing on the limestone. The mat was low enough to permit a basement under the building, thus providing space for auxiliary facilities that usually were located in structures around the main process building groups.

The use of the continuous mat practically eliminated the tedious hand cleaning and water flushing of crevices. While appearing more expensive than the spread footings used on the original buildings, this construction was found cheaper, when allowance was made for usable space in the basement. In addition, the mat type foundation furnished a solid and level surface that expedited construction of the rest of the building.

Design details of this foundation mat were made from day to day after general excavation had exposed the location of rock pinnacles and clay-filled crevices. The mat was keyed over rock pinnacles to hold them in place and reinforced to span from ridge to ridge. This type of foundation enabled construction work to be completed in a shorter time than was required on the buildings where pressure grouting was used to fill the crevices and support spread type footings.

Concrete and steel construction

Construction above ground was carried on by somewhat conventional means but on an almost unprecedently large scale. About 300,000 cu. yd. of concrete was placed with 13,000 tons of reinforcing steel in major plant buildings, and 19,000 tons of structural steel was erected.

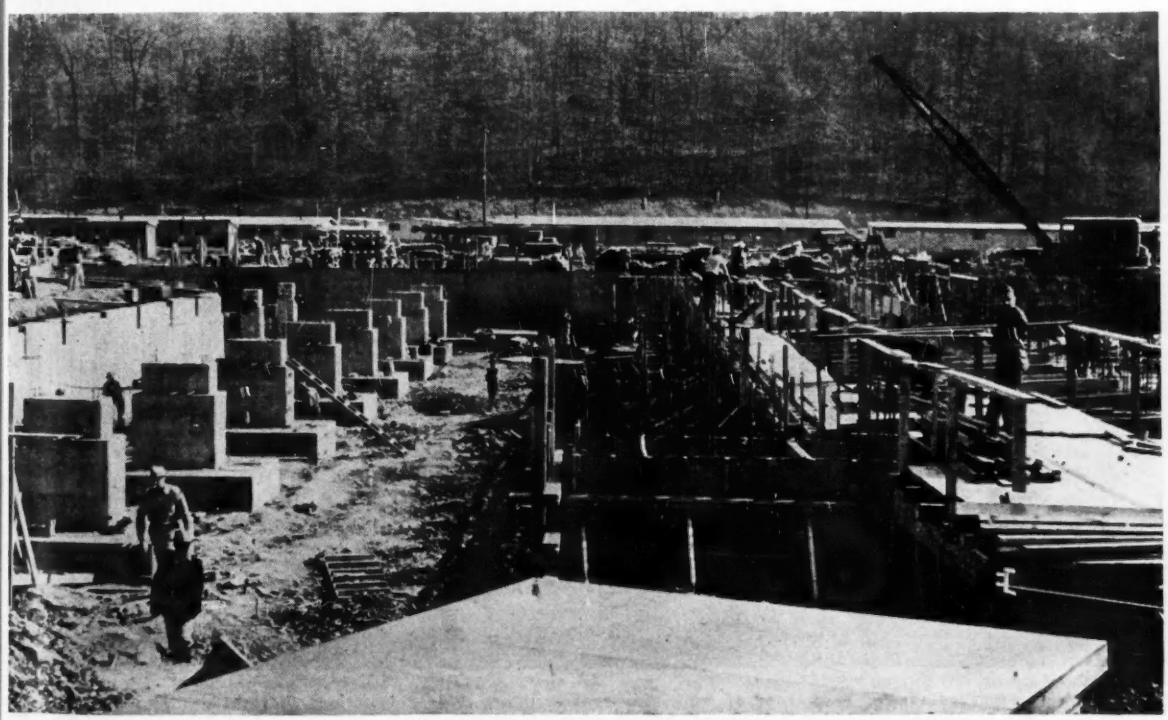
Few of the buildings are unusual in general design despite the very unusual equipment and secret processes they house. The first major structures built are concrete frame throughout, constructed with a minimum of then scarce reinforcing steel, while later buildings are steel frame. Both types have non-bearing walls of brick, tile or corrugated asbestos-cement sheets as availability dictated. Supplemental buildings, warehouses, cafeterias, change-houses and the like are one-or-two story wood structures located on natural undisturbed soil, using a bearing value of 4,000 psf.

Transit-mix delivery

Concrete was purchased delivered as needed from a subcontractor who erected a plant at the site. Aggregates and cement were batched into transit-mixers that hauled to point of placing. Concrete for the foundations was chuted to place if it could be done direct from the truck. Other concrete was placed by crane and bucket, sometimes supplemented by two-wheel buggies.

A large number of cranes was in use on the project varying from tractor units to wide-guage revolving type, the latter being essential to set some of the equipment at a long radius from the machine.

None of the buildings is very high so all the steel could be set with long boom cranes, some of which utilized a "goose-neck jib" with a total boom length of 125 ft. to reach over obstructions.



Foundation walls and column footings were formed with plywood held by light lumber. Truck-mixers delivered concrete.

Thermal Diffusion Plant Built Rapidly

Original estimate for completion of design and construction was set at six months. The schedule was advanced by General Groves to four months, and actually the plant was delivered in 75 days.

Lt. Col. Mark C. Fox
Corps of Engineers, Clinton Engineer Works
Formerly in Charge of Construction and Operation, Thermal Diffusion Plant, now, Chief of Construction and Engineering, Electromagnetic Plant

THE THERMAL diffusion plant at Clinton Engineer Works was designed and constructed within so short a schedule that the H. K. Ferguson Co. of Cleveland, which did the work, still do not exactly understand how they were able to do it. Even in a program where construction miracles were expected, this plant was spectacular.

General Groves decided to build this plant after P. H. Abelson, working for the Navy's research laboratory at Washington, proved that the thermal diffusion process was operable. This process involves a high heat transfer across a thin film of liquid or gas. If one side of this film is against a hot wall, and the other side against a cold wall, convection currents are established that cause upward flow along the hot wall and downward flow along the cold wall.

At the same time, due to diffusion, the lighter molecules of the gas or liquid tend to move toward the hot wall while the heavier molecules tend to move toward the cold wall. The two movements tend to concentrate the light molecules at the top of a column.

Dr. Abelson's columns consist of three concentric pipes, the inside pipe being a steam line. Saturated steam enters this pipe at the top and condenses as it flows toward the bottom. The latent heat in the steam provides process heat as the steam condenses. In the "annular ring" between this inside pipe and a second pipe is the material to be processed—uranium hexafluoride. Cooling water flows in a large annular ring between the outside of this second pipe and a 4-in. iron casing. The tremendous stresses established in bringing the column from room temperature to a condition where the outer pipe is cool while the inner pipe is hot required materials that could really "take it." In addition, uranium hexafluoride is one of the most corrosive chemical compounds known.

Each column acts as an individual

Thermal diffusion plant as viewed from roof of main steam power plant. Pipe connections at right are to high-pressure steam source. The auxiliary steam plant at left utilizes twelve oil-fired marine boilers—surplus when the destroyer-escort program was curtailed—to supply process steam.

unit, although a group of columns usually are operated in parallel. As described above, the condensing steam transmits heat through the film of liquid or gaseous uranium compound. The inner wall is hot and the outer wall is relatively cold. U-235 molecules diffuse toward the hot wall and are carried upward by currents of convection. Uranium compound enriched in the 235 isotope is then skimmed off at the top while the depleted uranium compound is taken off at the bottom. This process works most efficiently when providing only a slightly enriched product.

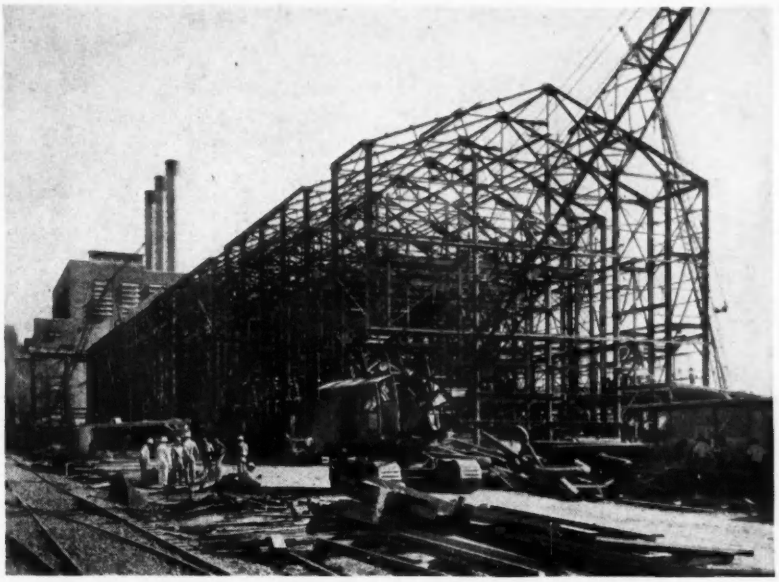
The electromagnetic plant was the only one in operation for nearly a year and there was a great desire to increase its production rate. This could best be done by increasing the percentage of U-235 in the feed material. Natural uranium has a concentration of 0.7 percent of pure U-235. If this concentration could be doubled in the feed material to the electromagnetic units their output could be correspondingly increased. Dr. Abelson had enriched considerable quantities of uranium to a 1.4-percent concentration of U-235 in his small plant at Washington and it appeared that a larger plant could be built quickly, using steam from the existing power plant for heat.

Built "right now"

On June 26, 1944, General Groves instructed the H. K. Ferguson Co. to proceed with the design and construction of the plant. The Ferguson company estimated that the plant could be designed and built in six months, providing top priority would be given it; so General Groves instructed that it be completed in four months. He later revised this schedule to three months, and actually, the plant was in operation in 75 days.

The main building is 525x82 ft. and 75 ft. high. It is a semi-standard design developed by Ferguson for which detail drawings were ready. A structural steel take-off was made on July 2nd. The WPB granted a Class 5 directive on July 3rd, and the steel was rolled on July 4th. Ground was broken on July 13th, and the first producing unit was processed for operation 66 days later.

The Ferguson company did the general construction and sublet the specialist work. Erection of the 2,000 tons of steel, for example, was done with their own forces, some 90 percent of it being set directly from the delivery cars without rehandling. Subcontractors on the job included the Edenfield Electrical Co., for electrical installations; Turner & Ross Co., Pittsburgh Pipe and Equipment Co. and the National Valve Co. on piping installations; the Tri-State Asbestos Co. for all insulation work and the Tennessee Roofing Co. for sheet metal installations. Pumps were furnished by Pacific Pump Co. with motors by Westinghouse. Mehring & Hanson Co. and the Grinnell Corp. furnished the process columns—after 23 major manufacturers separately agreed it was not possible to make the columns on a production basis.



This 525-ft. long building, filled with pipe, pumps and valves constitutes the thermal diffusion plant for which process steam was supplied by power plant.

Big pumping job

Equipment installed included 42 centrifugal pumps of 10,000-gpm. capacity driven by 100-hp. motors and four 15,000-gpm. vertical turbine pumps with 700-hp. motors, almost 15,000 valves, varying in size from ½ in. to 54 in. and from low pressure water to high pressure steam, and 50 miles of nickel tubing.

The plant was located adjacent to the main steam power plant of the Clinton Engineer Works for easy transfer of heat. But high pressure, superheated dry steam, while essential for power purposes, is not an efficient heating medium as it does not readily give up its heat. Consequently, it has been necessary to saturate the steam, which has been done by pumping "return water" directly into the 1,250-psi. at 900-deg. F. steam line, an expedient never before accomplished. Introduction of water from the hot condensate return line increased the volume of the steam while reducing both its pressure and temperature.

The Pacific Pump Co. adapted a pump, which they had been using to pump hot oil in Persia, to the job and three of these elaborate contraptions, known as "silver queens," were built and installed on time.

The Corps of Engineers personnel, under the author, included Maj. R. F. Looney, and Capt. Harry Burton on procurement and expediting, Maj. Thomas J. Evans, Jr., in charge of construction, and Capt. Van S. Reid, executive officer. H. K. Ferguson Co. was represented by W. N. Thompson, chief engineer, Frank Buck, chief mechanical engineer, W. K. Mitchell, general manager, C. W. Roberts, project manager, George Lindquist, general superintendent, and G. R. Byrd, mechanical superintendent.

As construction neared completion, the Ferguson firm formed a wholly-owned subsidiary, The Fercleve Corp., to operate the plant. Long before the construction forces moved out, the operators moved in, conditioned the columns and the piping and started to operate the plant.

Cooling towers and flumes in foreground handle a large volume of water, which is pumped to the huge process building.

Largest of the Atom-Bomb Plants

John F. Hogerton
Job Engineer, Kellex Corp., New York

● *The gaseous diffusion plant is one of the largest and most complex plants in industrial history. It has to be big to accommodate the enormous amounts of gas that must be recycled thousands of times to extract usable concentrations of U-235. A number of auxiliary systems are required, some of them sizeable plants in themselves. Two unusual features of the process systems are the unbelieveable cleanliness of everything connected with the plant, and the unprecedented vacuum tightness of the equipment.*

LARGEST OF THE GREAT plants for production of material for the atomic bomb is that for the gaseous diffusion method, which exists as a massive array of buildings in a large area at Clinton Engineer Works. The plant and appurtenances were designed and engineered by The Kellex Corp., organized for this project as a subsidiary of M. W. Kellogg Co., New York. Planning alone required 20,000 pages of specifications, 12,000 drawings and 10,000 pages of operating instructions.

Principal structure of the plant, and perhaps the most impressive of all those built in connection with the atomic bomb project, consists of a huge U-shaped installation, which contains the diffusion cascade and related process equipment. Four stories high, over a half-mile long and nearly a quarter-mile across, the structures cover an area of 60 acres. The interior of the U is at the level of the first floor while the outside is at the basement level. The buildings are of reinforced concrete to the main floor level, with steel frame and asbestos-cement siding from there to the roof.

The first level is occupied by auxiliary equipment—transformers, electrical switch gear, ventilating fans and duct works. The second and main level accommodates the diffusion stages, which are completely enclosed by welded steel panels. The third level is a pipe gallery, which carries the main process headers as well as a variety of auxiliary pipelines. The process headers, like the stages, are enclosed by steel panels. A volume of 6,000,000 cu. ft. is so enclosed and a "special atmosphere" maintained inside.

The fourth level is the operating floor. Here are installed the hundreds of instrument panel boards and control devices for operating the diffusion cascade. In a central location on the operating floor is a master

control room, equipped with instruments that make it possible to scan the operations over the entire cascade. From this central station one can set in motion robot controls for isolating sections of the cascade from the main process stream.

But what is a cascade and why is such a large plant required for production of small amounts of the finished product?

How diffusion works

As the name gaseous diffusion implies, the fissionable U-235 is separated from inert U-238 (with which it is found in nature in a ratio of 1 to 140) while it is in a gaseous state. The heart of this process is a highly specialized type of porous membrane, known as a "barrier" that contains hundreds of millions of pores per square inch. These pores are submicroscopic—their average diameter is estimated at two millionths of an inch. To understand how the diffusion process works, picture a barrier dividing a chamber into a high and a low pressure zone. If a mixture of light and heavy gases is pumped through the high pressure zone, the fraction that passes or "diffuses" through the barrier into the low pressure zone will be found to be appreciably richer in the lighter component of the mixture.

The extent to which any two gases can thus be separated in a single stage has been found to be proportional to the square root of the ratio of molecular weight of the gas molecules. One, if not the only, gaseous compound of uranium is uranium hexafluoride. With hexafluoride the U-235 has a molecular weight of 349, and U-238 a weight of 352 so that the theoretical separation factor is only 1.0043. Thus many hundreds of stages are necessary to obtain a very high concentration of U-235. In actual practice imperfect barriers and operating conditions necessitate even more than the theoretical number of stages required. The plant at Clinton Engineer Works actually contains several thousand diffusion stages and enough barrier to stretch from New York to Tokyo! Such a combination of stages is known as a cascade.

Several thousand stages require thousands of diffusers, thousands of pumps, thousands of heat exchangers, thousands of valves, thousands of instruments and miles and miles of pipe —all connected into one continuous system. Hence, the great plant.

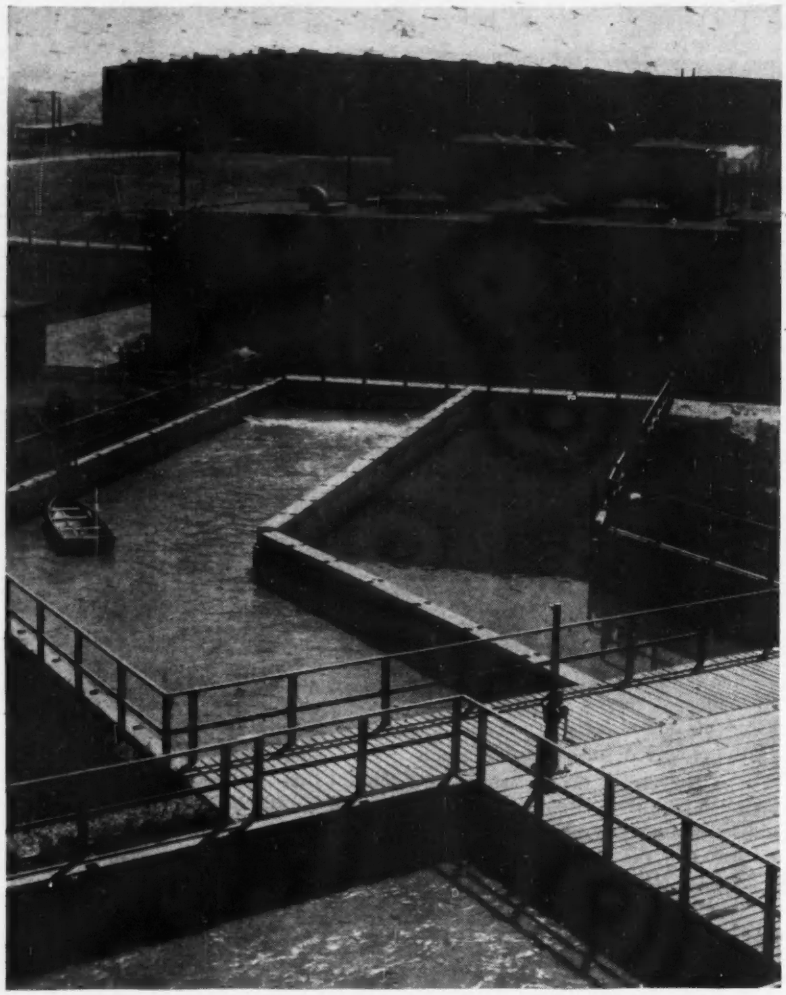
But the number of equipment units and the complexity of the system are only part of the story. Added to this is the fact that a cascade processing the uranium hexafluoride must be operated at reduced pressures and hence all process equipment must be vacuum tight. Further uranium hexafluoride is one of the most corrosive chemicals known, attacking practically all metals, non-metals, organics, and even water with equal relish. The problem is further complicated by the fact that even at reduced pressure uranium hexafluoride solidifies at around 100 deg. F.

Although the principle of gaseous diffusion was known as far back as 1829, this plant represents its first application outside the laboratory. Heretofore the materials to be separated have always had sufficiently dissimilar physical or chemical properties to permit the use of better known methods such as distillation, absorption, crystallization, or the like. The isotopes of uranium are such nearly perfect twins, however, that methods comparable to gaseous diffusion had to be developed for this separation.

Auxiliary System important

There are many auxiliary systems connected with the diffusion cascade plant that are of special interest. Located in the center of the U are a number of unusual plants, one of which is the largest air-drying installation ever built. Nearby, but outside the U, is one of the largest spray cool-

Inside the U of the main structure separate buildings house air-conditioning and other supplemental processes.



Large volumes of water are circulated for the gaseous process. These flumes connect to the cooling towers.

Viewed from any angle the gaseous diffusion plant is impressive, with acres of white asbestos-cement exterior walls.

ing tower installations ever made, part of a recirculating cooling water system that handles enough water to supply a city of 5,000,000.

There are many other interrelated parts of the plant—a "conditioning" area that is a large-scale plant in itself, laboratories where temperatures are maintained within two-tenths of a degree, offices, cafeterias, a hundred warehouses, bus terminals, garages, and miles of roads and railroads that normally go with the very largest industrial plants. Power for the process is supplied by a 238,000-kw. steam-generating plant, the largest single initial installation ever made.

Built by contractors

Such is the gaseous diffusion plant, built in its entirety on an undeveloped and remote site in barely two years time! This miraculous construction task was accomplished by the J. A. Jones Construction Co. Inc. and by Ford, Bacon & Davis, Inc., management contractors, with the Kellex Corp. acting as supervisor of construction. The plant is operated by Carbide and Carbon Chemicals Corp. The Jones Co. built the process plant, the administration area, power plant and yard facilities, while Ford, Bacon & Davis had the responsibility for the conditioning area. In addition, the two firms built labor camps to accommodate 12,000 men.

There are two terms that neither the Jones organization nor Ford, Bacon & Davis are likely ever to forget. One is cleanliness control and the other vacuum tightness. The former meant that the entire process plant had to be as clean as a surgeon's forceps and the latter that the plant had to be as vacuum tight as a thermos bottle.

Cleanliness of first importance

As an illustration of cleanliness a thumb print represented contamination in the gaseous diffusion plant sense of the word! All process equipment from individual valves to subassemblies of pipes had to be put through as many as a dozen cleaning operations, including sandblasting, degreasing, alkaline cleaning, acid pickling, and surface passivation. After cleaning, equipment was dried and then tightly capped to prevent contamination during handling. Certain equipment items were pressured

ith dry nitrogen to preclude any ossibility of moisture infiltration. Once cleaned, dried and capped, the quipment was subject to the procedure known as cleanliness control. he first step here was to partition f the building in which the equipent was to be installed and thorughly clean it from roof to basement. ot only was all construction debris eared away but all building surfaces, en the ceilings, were wiped down by nd or vacuum cleaned.

Once the building was cleaned, laborate precautions were taken to ep it that way. For example, the ilding was placed under forced raft ventilation and all air was filred; only essential trucks were pertted to enter the building and these ere hosed down; workers were adtted only after they had brushed eir clothing. This cleanliness conol program is thought to be one of e most unique activities ever enountered on a construction project. Vacuum tightness presented entirely different problems. Here it was necessary to develop more than a dozen welding techniques as well as techniques for locating and repairing the most minute leaks. As many as 1,200 welding machines were in use at one time with both pressure and vacuum testing brought into play in testing the installation. The former was used for locating gross leaks and the latter for locating small leaks and measuring final tightness.

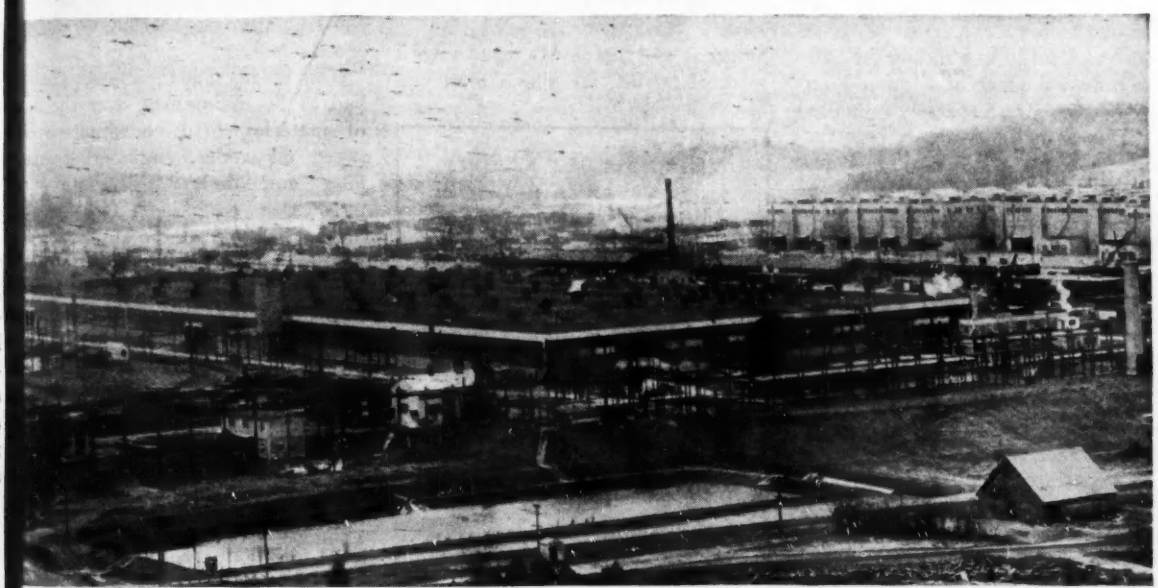
In the vacuum method the unit under test is continuously evacuated by a high speed pump, while suspected areas are probed with a special gas. Traces of the probing gas in the exhaust gases indicate leakage.

Welding by the mile

Other unusual construction problems encountered in building the gaseous diffusion plant were the erection of air-tight stage enclosures, which involved nearly 1,000 miles of air-tight welding and which engaged as many as 400 sheet-metal workers at one time; the installation of 3,300 miles of electrical conductors and 825 miles of electrical conduit, involving more than 90,000 separate tests on electrical systems; and the installation of thousands of precision instruments requiring 4,000,000 ft. of copper tubing and 3,000,000 ft. of copper wire.

On the structural side is the fact that the U and related structures were built on compacted fill, a method that up until then had not been extensively used in building construction. A separate article describing this work appears on page 144. Another structural feat, described on page 141, was unprecedently rapid planning and construction of the power plant requiring less than a year from inception of the idea until power was delivered.

Activities of the Kellex Corp. at Clinton Engineer Works was directed by P. C. Keith, vice president; A. L. Baker, project manager; and A. A. Nickman, resident engineer.



Essential Unit of Gaseous Plant Constructed by Ford, Bacon & Davis

Conditioning" plant in foreground as designed and built, and for a time perated, by Ford, Bacon & Davis, Inc. r part of gaseous diffusion process. ork carried on in the structure includes preassembly of process equipent into large units and cleaning of rocess parts prior to installation. Flexibility was a prime consideration designing the 400x1,000-ft. one-story d part basement steel-frame structre, which has walls largely of sash. interior bays are 40x40 ft. throughout the building, with only temporary partitions provided so that alterations can be made as necessary to meet constant changes in the plant.

An example of built-in flexibility is found in the means for meeting varying demands for power throughout the structure. Unit substations, each including a large power transformer and associated switching equipment within a single housing, are located at convenient points outside the wall. As changes occurred in the power demand, the substations were shifted or units added to keep the length of low tension leads and the amount of line-loss to a minimum.

For Ford, Bacon & Davis, Inc., Carl A. Schneider was in charge of design, done in the New York Office. C. C. Whittlesey was project manager on construction of the conditioning building and other related structures.

Organization Set-up For $5,000,000 a Month Payroll

Edwin L. Jones
General Manager, J. A. Jones Construction Co. Inc.
Charlotte, North Carolina

● **The Jones organization was set up in six major divisions to handle construction totaling $300,000,000 at Clinton Engineer Works. Activities on the main gaseous diffusion plant were directed by a project manager with authority delegated through superintendents for each craft and even further to the supervisor on a group of several building units. Subcontractors are given a large share of the credit for the accomplishment.**

SIZE OF PAYROLL is not a good criterion of work accomplished but under existing security restrictions it is perhaps the best means of picturing the size of the job done by J. A. Jones Construction Co. in building the gaseous diffusion plant at Clinton Engineer Works. On a sparsely inhabited rural area in Tennessee a construction force was built up in a few months to a sustained payroll of $5,000,000 a month with weekly peaks in excess of $2,000,000. The total cost of work on the one area at Clinton that was handled by this firm will exceed $500,000,000 including purchase price and installation costs of process equipment.

The Jones organization moved into one corner of the 59,000 acre government reservation in May, 1943, with a contract to build a steam power plant, which was the largest initial installation of this type ever made. In September, they were authorized to build the gaseous diffusion plant in the least possible time. It was necessary to build a camp to accommodate 12,000 construction workers, as well as to provide roads, bridges, a railroad, bus terminals, and huge parking lots accessible to the working area.

Later, to meet increased demands for heat, three additional steam plants were erected. And finally, an addition to the diffusion plant was built, to greatly increase the amount of material processed.

Due to the unremitting pressure for completion of the project at the earliest possible date, work was carried on seven days a week, 10 hr. a day, Monday through Friday, and 8 hr. on Saturday and Sunday, to make a work week of 66 hr., for which most employees were paid for 79 hr. of work. Sunday work was discontinued early this year.

The principal difficulty in organizing the job was caused by the fact that each unit had to be built "all at one time." As soon as plans were partially ready a schedule for completion was established, and lagging behind was not tolerated. In some few instances such speed was perhaps not justified, but no one knew in what part of the plant delaying difficulties might occur, so every phase of construction was carried on at top speed.

This meant that the closest control had to be maintained over the flow of material, field coordination between all trades, engineering planning and design, installation of production equipment, and finally the testing and pre-operational runs. There was no "leeway" in the construction schedules, and speed had to be maintained without any excuses.

PRINCIPALS IN J. A. JONES ORGANIZATION

General Manager
Edwin L. Jones

Power Plant and Utilities
J. E. Davidson, Project Manager
W. H. WcWhirter, Gen. Supt.
John D. Watson, Chief Engineer

Main Process Plant
H. V. Appen, Project Manager
J. C. Doucha, Asst. Project Manager
A. C. Samford, Gen. Superintendent

Administration
A. V. Junkin, Manager
O. E. Breuggeman, Engineer, Contract and Claims
A. G. Underwood, Supt. Personnel

Materials Control
T. F. McVeigh, Gen. Superintendent
M. E. Ober, Procurement
L. R. Cornish, Receiving & Warehsg.

Inspection
A. L. Crawford

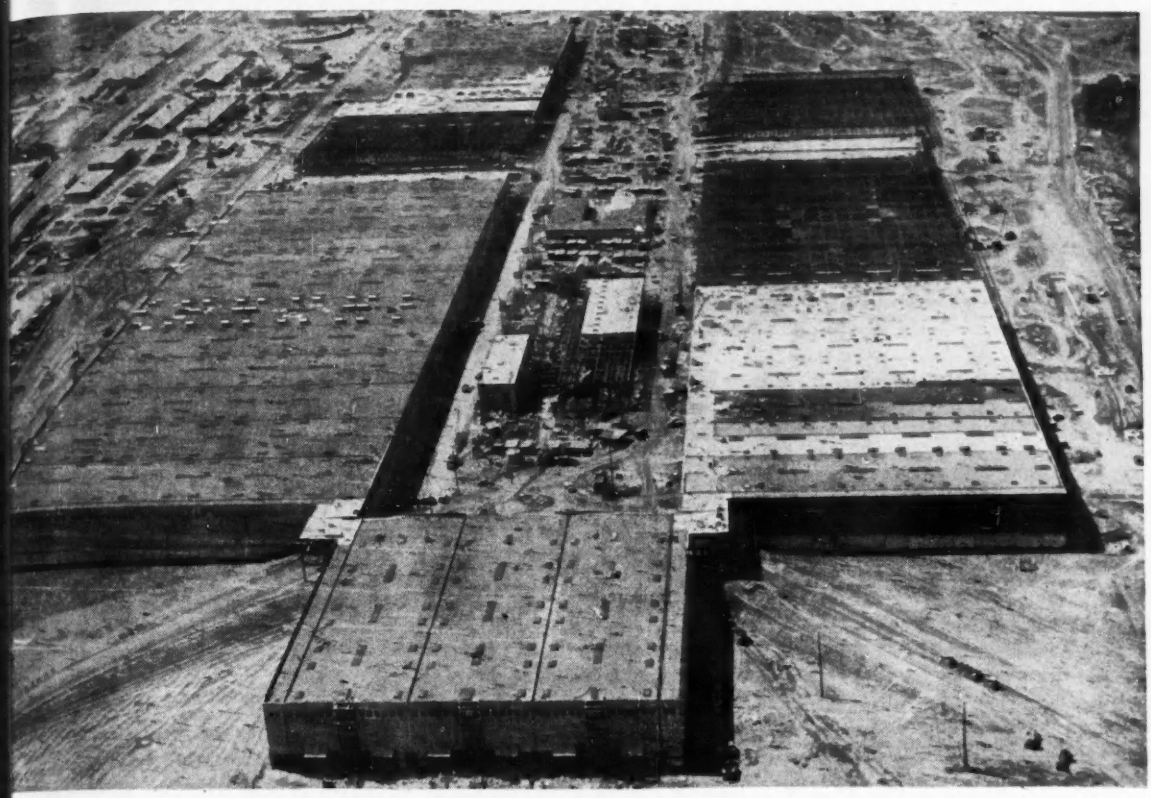
Safety
D. N. Kelly

Departments under a single head

Despite the close coordination required, definite separation of the work into functions and areas proved to be very successful.

There were six major divisions of the company's organization that reported directly to the general manager. Construction accounted for two of the divisions, each of which was run independently by a project manager. Each unit was assigned a substantial portion of the work and separated from other units by an easily defined natural boundary.

Administrative functions were kept entirely separate from that of construction and engineering, so as to leave those groups free for their special jobs. An administrative division, operating under its own manager had full charge of personnel



Main structure for the gaseous diffusion plant is in "U" shape 2,500 ft. on a side by 400 ft. wide and made up of several connected "buildings" housing the many thousands of "cascades" used in the separation process.

timekeeping and payroll, plant security, contracts and claims as well as plant service. This division handled the recruiting of labor, timekeeping and payrolls for the three fixed-fee sub-constractors as well as for the general contractors.

The materials control division had full charge of all purchases, priorities, procurement and expediting of materials and supplies as well as the receipt, warehousing and distribution of all items. This division did all auditing and was responsible for the payment and reimbursement of all bills for the general contractor and for the fixed-fee subcontractors.

An extremely high standard of perfection for the installation of all the process piping and equipment was established, and to the general contractor was given the responsibility for seeing that these specifications were carried out to the letter. To accomplish this an inspection division was set up and divided into sections with an experienced engineer in charge of each section such as structural, electrical, mechanical, instrumentation, and the like. The safety department also reported directly to the general manager.

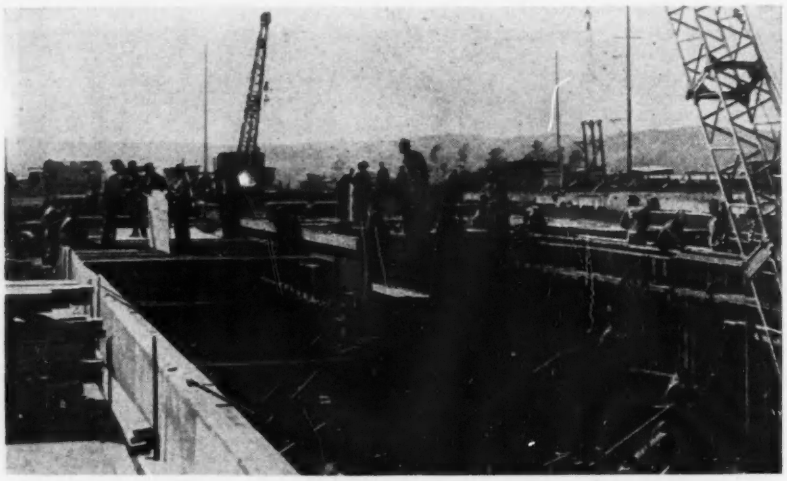
Construction plant design

The general contractor maintained a design engineering department in the field to prepare plans for temporary construction and camp buildings, including such unusual construction facilities as a bowling alley, an ice plant, village stores, and a locomotive repair shop. This department also designed the permanent water treatment plant, a large part of the

PRINCIPAL STRUCTURAL SUBCONTRACTORS ON GASEOUS DIFFUSION PLANT

(Exclusive of power house)

Firm	Home Office	Work performed
D. W. Winkleman	Syracuse, N. Y.	Railroad and site grading
Oman Creighton Co.	Nashville, Tenn.	Site grading
Wolfe-Michael Const. Co.	St. Augustine, Fla.	Site grading
Bethlehem Steel Co.	Bethlehem, Pa.	Fabricate and erect steel
Virginia Bridge Co.	Roanoke, Va.	Fabricate structural steel
Lambert Brother	Knoxville, Tenn.	Concrete aggregate
Birmingham Slag Co.	Birmingham, Ala.	
Cooney Brothers	Tarrytown, N. Y.	Mix and deliver concrete
H. E. Anning Co.	Chicago, Ill.	Poured in place gypsum roof
L. K. Comstock	New York, N. Y.	Process plant electrical installation
Bryant Electric Co.	High Point, N. C.	
Midwest Piping & Supply Co.	St. Louis, Mo.	Process area piping
Poe Piping & Heating Co.	Greenville, S. C.	Process area piping
G. G. Ray & Co.	Charlotte, N. C.	Roofing and sheet metal
Kerby-Saunders Inc.	New York, N. Y.	Sheet metal work
Ce-Mas-Co Floor Co.	Chicago, Ill.	Asphalt mastic floor



Forms for the floor of the gaseous diffusion process building were largely prefabricated. Concrete was placed by pumping throughout the building.

water distribution and the sewerage systems and the sewage treatment plant. Plans and specifications were prepared for two major bridges as well as for 25 miles of primary access roads.

Each a big job in itself

A few figures give some idea of the magnitude of the work involved and show why the contractors organization had to be flexible and departmentalized so as to secure specialization, and yet so integrated as to have a minimum of friction or lost motion. For the two main process plants described above 2,500,000 cu. yd. of excavation were handled; 500,000 cu. yd. of compacted fill were placed, under laboratory control: 450,000 cu. yd. of concrete was placed; 14,000 tons of reinforcing steel was installed and 40,000 tons of structural steel erected.

In the main process plant area the principal structure is the gaseous diffusion process building. This is a "U"-shaped structure 2,450 ft. long, and 400 ft. wide on each side, with a floor area of 5,560,000 sq. ft., making it one of the largest connected industrial buildings. It has a concrete basement, with concrete frame and slab for the first floor, and steel framing for the second and third stories. This design served the purpose of saving steel and also permitted a rapid start of construction while the structural steel for the upper parts of the buildings was being rolled, detailed, fabricated and delivered.

Concrete was delivered in mixer-trucks and pumped to the footings, columns, and floor slabs. Steel was erected by conventional cranes. Asbestos-cement sheets were substituted for brick on the outside walls to reduce the amount of on-site labor required.

A general superintendent directed 9,000 to 15,000 employees on the main building and on immediately tributary work. Under the general superintendent was a superintendent for each of the several classes of work, and also a building superintendent for each of the several types of structures. The various building units within the main structure were divided into groups of three to six, depending somewhat on the ability of the building superintendent and the urgency of the requirement for the particular structures.

JONES AND FIXED-FEE SUBCONTRACTORS FORCE DISTRIBUTION

(Largest week, May 12, 1945)

Classification	Employees
Laborers & tenders	2,753
Carpenters	2,439
Cement finishers	84
Electricians	2,644
Ironworkers	859
Painters	175
Plumbers, steamfitters	5,472
Sheet metal workers	1,059
Boilermakers	355
Bricklayers	43
Firemen & oilers	326
Mechanics	389
Machinists	423
Equipment operators	406
Truck drivers	736
Other crafts	492
Craft foremen	1,901
Manual	20,556
Non-manual	4,229
TOTAL	24,785

Coordination of all phases of the plant construction was one of the most difficult things that the management of the general contractor had to solve on this project. Since construction kept pace with the design work there was little opportunity for advance planning or scheduling. This difficulty was met by a general coordination meeting of the prime contractor with the subcontractors and the designing engineers and, fully as important, by regularly scheduled meetings at least weekly with departmental engineers and superintendents for each of the major subdivisions of the construction program.

Subcontractors play big part

Equipment was installed by the general contractors own forces, handled as a part of the work under the project manager and the general superintendent of mechanical erection. Process piping and controls, however, were installed by subcontractors and credit for the speed and success of the installations goes in large measure to the experienced firms who undertook to do the work on such exceptionally rapid schedules.

Piping, electrical and instrumentation installations had to be coordinated and space provided for all of the intricate maze of installed equipment that is essential to the process. This required a tremendous amount of work by millwrights and boilermakers, and was accomplished rapidly despite some necessary changes by cooperation of all from designer to craftsmen.

Process gas piping was fabricated and installed by the Midwest Piping and Supply Co. of St. Louis, Mo. All other piping—including water, steam, air, gas vent, and refrigeration—was installed by the Poe Piping and Heating Co. of Greenville, S. C. The electrical work was installed by the L. K. Comstock Co. of New York and the Bryant Electric Co. of High Point, N. C., operating as co-venturers. These three subcontracts were awarded on the basis of cost-plus-a-fixed-fee and

ut sixty unit price subcontracts e let for specialized features of the k.

o house and feed 12,000 construc- workers on the gaseous diffusion nt area, a separate unit for camp rations was set up under a super- ndent. Prefabricated huts were ted first to provide immediate sing. Later, many dormitories, accommodating 132 men in ble rooms, were built. Nine hun- d government-owned trailers were ed in to house families. Parking e and adequate sanitary facilities e installed for privately owned lers. Stores and recreational fa- ies were provided for the camp.

Meals on the grounds

ix cafeterias were operated to e breakfast and dinner. No hes were served to construction kers and canteens were not per- ted in the working area. How- . at noontime trucks equipped as es were driven into the work area ell sandwiches, cakes, soup, cof- and cold drinks.

o organization is any better than key personnel. The J. A. Jones Construction Co. had a versatile, experienced, and loyal organization on this tremendous undertaking, and each of those in key positions were top men in their specialty. The whole organization was imbued with the idea that they were building something vital to the war effort.

The management is convinced that it successfully met the demands for speed and perfection, and completed the atomic bomb plant on schedule, because of the type of organization used—flexible, departmentalized, yet closely integrated, and because of the calibre and loyalty of its supervisory forces, as well as of the rank and file of its employees and subcontractors.

A trailer, dormitory and hut camp, separate from the town of Oak Ridge, housed up to 12,000 workers in the gaseous diffusion plant area.

uilding A Power Plant in 10 Months

John D. Watson
Chief Engineer, J. A. Jones Construction Co., Inc.

UND WAS BROKEN for the boiler se and turbine room foundation June 2, 1943, and the first unit 238,000-kw. steam power plant, ed at the Clinton Engineer Works ennessee went on the line April 1944. Built in 10 months the t has three boilers, each with a d capacity of 750,000 lb. per hr. superheated steam at 1,325 psi. 935 deg. F, and includes several o-generators, ranging in size from 0 to 35,000 kw. It is believed e the largest initial steam instal- n ever made and was built to t a large demand for firm power was necessary for the gaseous sion method of separation of nium 235 from U 238.

lthough wartime shortages made truction difficult they also con- uted to the fast start that it was ible to make on the job. Two e boilers and several of the turbines and generators, for example, were being manufactured to replace obsolete vertical units at the Fiske St. station of Commonwealth Edison in Chicago, and because of wartime necessity were commandeered for installation at C.E.W. In addition much other equipment was obtained on high war-induced priority.

Specialist firms used

Urgency of the operations compelled the architect-engineers to let, simultaneously with the general construction contract, separate prime contracts for the furnishing and fabricating of the boiler house and turbine room structural steel, for the electrical work, for the piping, for the furnishing and erection of the boilers and the pulverizer mills, as well as for the furnishing and erecting of the precipitators.

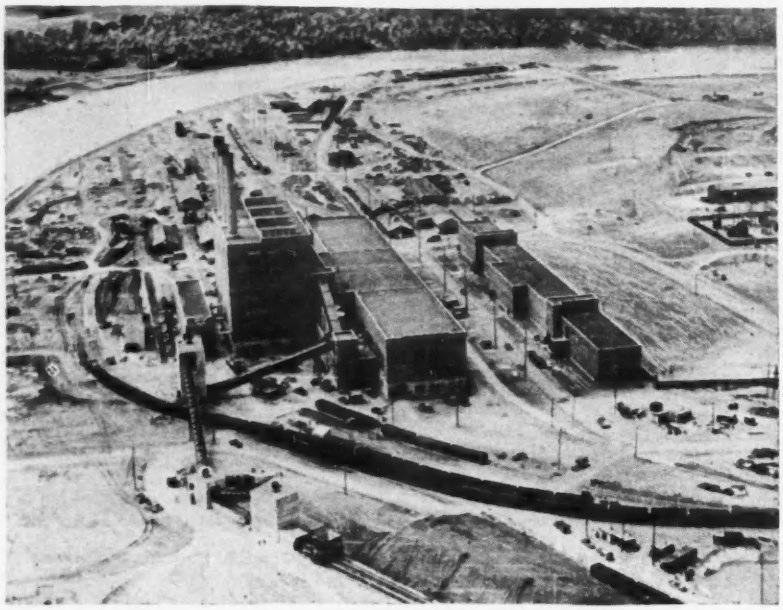
The general contractor, in turn, let to subcontractors the caisson foundations for the boiler house, erection of the main structural steel frame for the boiler house and the turbine room, guniting in the coal bunkers and slag tanks, turbo-generator erection, and insulation.

In addition to the boiler house and turbine room there was constructed for power control a main switch house of reinforced concrete and brick (69 x 635 ft. in plan), an auxiliary switch house for the operation of boiler auxiliaries, a river intake crib and tunnel for condenser cooling water, a pump house, a discharge tunnel and flume, a 154 kv. outdoor switch yard, a service building and complete coal unloading, breaking, conveying, stacking and recovery facilities.

The structures required a total of 87,000 cu. yd. of concrete, 4,600 tons of structural steel, and 4,300,000 brick. The peak employment was 5,600 men, most of whom worked on a 10-hr. day shift.

Difficult access

The site selected for the power plant was at an isolated area on the Clinch River, seven miles from a railroad



Steam power plant of 238,000 kw. capacity built in record time at Clinton Engineer Works. Note 225,000 ton coal storage and recovery equipment in foreground as well as large available work and storage area around the entire plant. Building at right is main switch house. The Clinch River, source of cooling water, is in the background.

and accessible only over narrow gravel roads. One access road was restricted by a hand-propelled ferry with a capacity of two passenger automobiles. The other road had a single lane, 8-ton capacity bridge. No electricity or telephones were available immediately, and other contractors, already in the area, had absorbed all available labor.

Yet, six weeks after the first representative of the general contractor reached the site, a camp to house 1,500 men was opened, complete with mess hall, temporary water supply and sewerage system, and all major parts of the construction was underway. Construction of office, shop and warehouse buildings was carried on simultaneously with start of work on the power plant proper.

Building the power house

Several innovations in construction, as well as the letting of portions of the work to specialist firms, contributed to completion of the power house on the exceedingly rapid schedule carried out.

Plans for the structure for housing the boilers and turbines were available from Chicago and were adaptable to the C.E.W. site, with modifications to add space for an additional unit. The original steel already had been erected and enclosed at the Chicago plant so it was not moved. However, the same fabricator was directed to duplicate steel, so that new shop drawings were not required and steel could be immediately fabricated and delivered for the structure, which has a height equivalent to a 14-story building.

Doubtful foundations

The site for the plant, to be near water necessary for condenser cooling and low to avoid pumping, is on the flood plain of the Clinch River. Underlying soil is clay, giving way to shale and shattered lime-stone interspersed with clay seams and a 1- to 5-ft. thick layer of sand over rock at a depth of 35 to 40 ft. The original plan for support of the boilers was to sink forty 6-ft. dia. caissons by the Chicago-well method, *i.e.*, excavation would be done in the open in steps of 5 ft. and, after the excavation was completed in each step, vertical wood lagging would be placed and supported by steel rings.

In putting down the caissons, it was possible that one or more of them would strike a seam in the rock that was open all the way to the river, a distance of less than 500 ft., or the sand stratum directly over the rock might have been under full hydrostatic pressure from the river. If either of these contingencies occurred the use of compressed air would be required to reach a satisfactory foundation, and the change from open excavation to compressed air would be difficult and time-consuming.

Dropped-in caissons

To eliminate the delays that might follow a blow-in, the contractor recommended "dropped-in" concrete caissons, and their use was accepted by the engineers. In this method, precast concrete caissons were sunk to solid rock by open dredging. The top of the caisson was poured with a circle of anchor bolts so that an air-lock could be installed in a few minutes. A battery of compressors was made available and air-locks were brought to the job. Fortunately the use of compressed air was not required though some difficulty was encountered that required considerable pumping.

Security restrictions imposed on everything connected with the atomic processes limit what can be told about the plant. However, a large number of construction expedients were used that assisted materially in cutting down the time required for construction. For instance, to avoid slow and expensive work in the Clinch River bulldozers were used to push earth into the edge of the stream on which a 62 x 57-ft. cofferdam was built for construction of the intake crib. On this "island" a double timber frame was set up and steel sheetpiles were set around it and driven to rock. Earth inside was clammed out and used to help seal the bottom of the sheets where, due to the irregular rock bottom, the cofferdam could not otherwise be made watertight.

Ten acres of built-up ground

Excavation for the discharge tunnel was carried down to groundwater with tractors and scrapers. When the bottom became soft, work was continued with draglines and clamshells. The spoil from all excavation was used to fill low ground, ten acres thus built up being used for a material storage yard.

Foundations were ready and steel available before a railroad spur into the job was completed so structural members for the boiler house frame had to be trucked-in 13 miles from the nearest siding. First of the three

ston drums for the first boiler was ced about four months after start the job, while erection of 4,600 s of boiler house and turbine room uctural steel was completed in 85 apsed days.

Two guy derricks were used to ect the heavy structural steel frame the boiler house. Tugger hoists se- ured to the columns handled the hter pieces. Crawler cranes be- n setting steel in the pump bay d in the turbine room before the iler house was topped out.

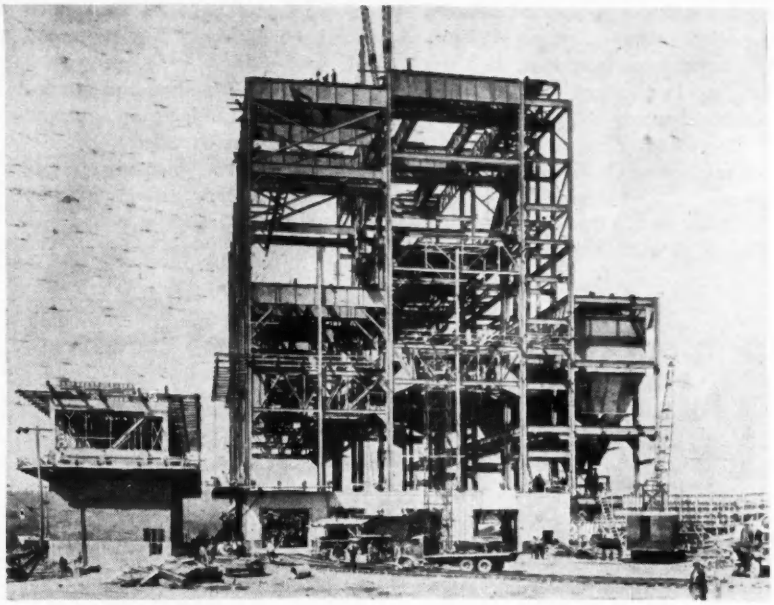
Gallery steel set early

Somewhat of an innovation in wer house construction was the ly installation of framing and ting for the galleries. Ordinary ctice has been to use temporary ffolding and ladders to avoid inter- ence with placing the piping and xiliary equipment. Actually, in- allation of the permanent gallery el gave access for all crafts with minimum of confusion, and sub- ntially speeded the work.

To save four weeks time in en- sing the boiler house the brick- rk was started from scaffolds hung m about mid-height of the struc- e, while erection of steel to the was continued. Openings were t in the walls and in the roof to rmit bringing in heavy equipment. e of precast slabs for the roof made a simple matter to leave openings erever desired.

Other factors contributed substan- lly to the speed of construction. e was the availability of adequate ce around the structures for access all sides and for storage of parts d supplies in such a way that any eded piece could be moved in easily. ilroad tracks were laid into each d of both the boiler house and the bine room so rail cars could be d for final delivery of heavy terial, even before the rail connec- n to the outside was completed. rk was organized on a production- e basis with the same crews doing same work for each of the several ts.

Another important factor in speed s availability of all kinds of large ipment. Due to the size and com- xity of other work underway rby almost every known kind of nstruction equipment was in use on site and could be made available needed for the power house con-



Concrete-frame switch house for boiler auxiliaries rises at left as guy derricks erect steel for the boiler house. The boilers are suspended on springs from the framing seen at the top center of the steel, while stacks and fans occupy the bay to the left. Note bricklayers' scaffold hung from mid-height.

struction. For instance, the overhead cranes were too slow for placing mass sections of concrete, so concrete, delivered by mixer-truck, was pumped from a machine set up outside the building.

Schedule difficult to meet

By Dec. 1, six months after start of construction, the building was enclosed. Window frames were late, but anchorages were arranged to hold them without "toothing" the brickwork. Temporarily, all openings were covered with tarpaulins, and a steam heating system was improvised to replace salamanders, making working conditions reasonably pleasant.

After Christmas, the pressure to meet the scheduled completion date became intense. The boiler erector began double shift operations, the night crew sorting out and placing the material so the day shift could devote full time to erection. A satisfactory hydrostatic test on boiler No. 1 was 23 days ahead of schedule.

Installation of the pulverizer mills and the forced and induced draft fans of the first unit was completed in February, but receipt of the slag tanks was delayed. Date of delivery of the boiler feed water pumps was critical and uncertain, and receipt of piping and valves for the first turbine had slowed down to a trickle. And finally, the last shipment of parts for the first generator was mistakenly shipped L.C.L. instead of by express.

In March, the situation looked better. The intake crib and tunnel, pumphouse, and discharge tunnel were given a final inspection and accepted. The drying-out fire was started in boiler No. 1 on March 8,—one week ahead of schedule.

In April, boiler No. 1 was tested under steam pressure and the safety valve was set. The first turbo-generator was turned over slowly under test, and finally on the morning of April 15, the machine was brought up to speed, synchronized, and put on line. By the end of April, building construction, except for painting, was complete in the turbine room, the service building, the auxiliary switch house, and the main switch house; and the boiler house was 95 percent finished. The second and third boilers were completed three and six months, respectively, after the completion of the first.

Lt. Col. William P. Cornelius represented the Manhattan District of the Corps of Engineers. A. A. Nickman, resident engineer for Commonwealth Edison on the Fiske St. station work, who already had planned the installation in Chicago, was retained by Kellex Corp. to represent the architect-engineers on the project. For the

general contractors, J. E. Davidson was project manager, W. H. McWhirter, general superintendent, and the writer, chief engineer.

Electrical work was performed by A. S. Schulman Electric Co. of Chicago, and piping by William A. Pope Co., also of Chicago. The Foundation Co. of New York supervised installation of the "dropped-in" caissons, and Bethlehem Steel Co. erected the structural frame for the main plant.

Boilers were furnished and erected by Combustion Engineering Co., and precipitators were supplied by the Research Corp. The turbo-generators and condensers were manufactured by Allis-Chalmers, General Electric and Westinghouse.

Compacted Fill Equals Natural Ground

John D. Watson
Chief Engineer

O. R. Bradley
Soils Engineer

J. A. Jones Construction Co., Inc.

MOUNTAINOUS NATURE of the terrain at the Clinton Engineer Works, which made the site desirable from many viewpoints, made it difficult to obtain unyielding foundations. This was especially true of support for the huge U-shaped building (2,500 x 400 ft. for each leg and 400 ft. across the inside of the U) that houses the main plant of the gaseous diffusion process for separation of U-235.

The design requirements provided that the same floor elevation be maintained throughout each of the many separate but connected building units composing the U thus, requiring construction over high fill and adjacent deep cut areas. Each building consists of a basement and first floor of reinforced concrete, while the framing of the second and third stories is structural steel. The ground elevation inside the U is the same as the elevation of the first floor slab, while the area around the outside of the building is graded to the elevation of the basement.

A site of 130 acres was prepared in accordance with this requirement for a single building area. During a four-month period the site was graded and concrete operations advanced enough to stay ahead of structural steel erection. Topography of the site was such that fills up to 23 ft. in height were required, while a cut 46 ft. had to be made on one hill. In all, more than 2,000,000 cu. yd. of earth were moved.

Three plans for support

The question of how to put in the building foundations on the fill areas of the site was the subject of much discussion. One plan was to place spread concrete footings on undisturbed soil, and extend columns up to the basement floor level. Fill was subsequently to be placed between the footings and columns by dump trucks. This method was eliminated because no grading subcontractor could be found who would undertake the filling between the footings and columns in the time allotted.

Another plan was to complete all grading operations as rapidly as possible, and drive pile supports separately for each footing. This would have been a slow and costly operation and would have failed to provide adequate foundations for many pieces of heavy equipment that were to be set in the basement and whose location had not then been established.

Finally, the suggestion was made that all filling be done in 6-in. layers which would be thoroughly compacted with sheepsfoot rollers after the manner of earth dam and highway embankment construction. Then the footings could be founded directly on top of the new fills, a revolutionary idea in the field of building construction. This method was adopted.

Excess moisture caused difficulty

A major difficulty encountered in making the fills was the fact that the natural moisture content of the red clay was considerably above the optimum required for compaction; for example, 5 ft. below the natural ground surface the moisture content averaged 33 percent. As a result all the soil used in compacted fills had to be plowed, aerated, and dried out.

After careful stripping of all vegetation and top soil down to firm subsoil some 300,000 cu. yd. of compacted fill was placed in the areas shown dotted in Fig. 2. In addition to the specially compacted fill, 875,000 cu. yd. of material was placed in the center of the "U" and on the out

Fig. 1. Typical of support problem is area where ground changes from cut to fill and where equipment requiring unyielding support is in a varied pattern. Winter concreting is underway in background.

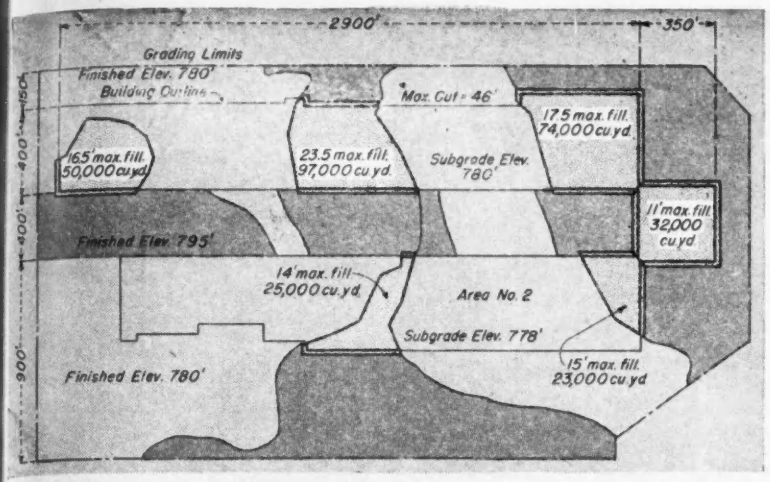


Fig. 2. Dotted areas required special compaction of fill to provide support equal to that of natural ground. Dark shaded areas are fill where reasonably good material was spread in 6-in. layers and compacted only by equipment travel.

side of the buildings. Only material with reasonably good bearing qualities was used for the outside areas and it was spread in 6-in. layers, but was compacted only by the travel of equipment. Excavation and fill was subcontracted to three firms, so filling operations were nearly always in progress on three embankments simultaneously, and sometimes on four.

Supplementary price for compaction

A fixed rate of 27c. per cu. yd. was paid for all excavation and dumped fill. The specially compacted fill under the building site was paid for by a supplemental, or additional, price of 39c. per cu. yd. in place, while a supplement of only 5c. was paid for fill material placed where special compaction was not required. This method of paying a premium price for compacted and special fill in place was decided upon when it was seen that much of the excavated material would have to be wasted either because it was too wet, or because it contained too much loose rock.

Original specifications for the specially compacted fill had provided that the material be placed in 6-in. layers at or near the optimum moisture content, and that the rolling be done with sheepsfoot rollers exerting a pressure of 300 psi. Rolling was to be continued until a density equal to 95 percent of maximum (as indicated by the modified American Association of State Highway Officials tests) was reached, and the completed fill was to have a dry density of 90 lb. per cu. ft. to carry a load of 5,000 lb. per sq. ft.

Actually, requirements had to be relaxed somewhat when it was found that three of the seven common soil types could not be compacted to a dry density of 90 lb. per cu. ft. with the equipment specified. The average dry density obtained in the embankments, however, was 87.5 lb. per cu. ft., which compared with 86.6 lb. per cu. ft. for undisturbed soil in the borrowpits.

Half of time lost

The placing of specially compacted fill under building sites began Oct. 10, and was completed Dec. 23, 1943. Between those dates there was a total of 1,390 possible working hours, assuming two 10-hr. shifts per day. Of this time 338 hr. was lost because of rain, 395 hr. because of excessive field moisture, 80 hr. because of frost

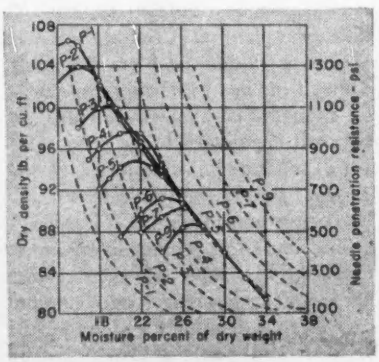


Fig. 3. Moisture content related to density and needle penetration for rapid identification of soil types.

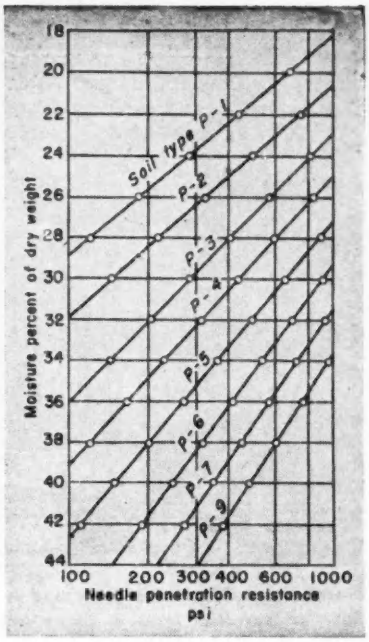


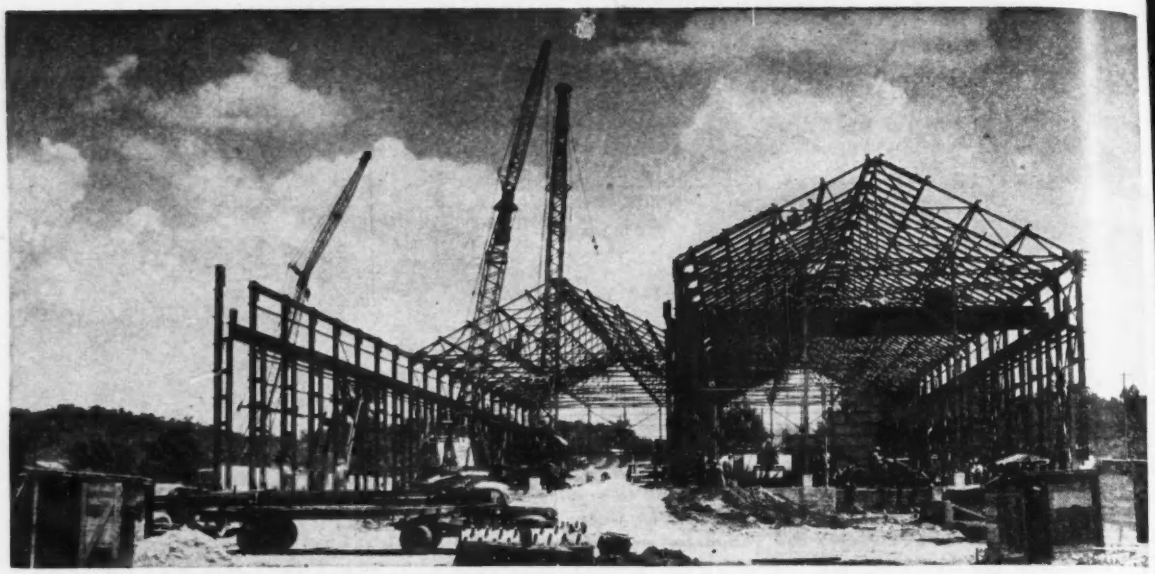
Fig. 4. Moisture-density and needle penetration resistance curves for compaction control of different soils.

in the ground. In each of the 577 hr. remaining the grading subcontractors had to average better than 500 cu. yd. of compacted fill.

Profit from TVA experience

Nine soil types were intermingled over the entire site with scarcely any excavation or borrow area composed wholly of one type. A satisfactory identification of the several types could not be made by eye, nor could testing be done sufficiently far in advance to take care of the sudden changes in types that were encountered. The Tennessee Valley Authority had had the same difficulty when constructing earth embankments for dams in this region and engineers on this project profited by TVA's experience, using methods of identification and testing similar to those devised by F. H. Kellogg, soils engineer of TVA. (*ENR*, Oct. 22, 1942, vol. p. 550)

The regular pattern of the penetration resistance—moisture curve is apparent in Fig. 3. If these curves are plotted on semi-logarithmic paper, Fig. 4, they appear as straight lines. By placing a sample of soil in a compaction cylinder according to standard methods, pushing a needle into the sample, and then by making a quick determination of the moisture content of the sample, two values



Warehouse built on sloping ground is supported on spread footings over compacted fill as much as 17 ft. deep. Fill for floor at car-door level is shown being completed by compaction units.

(penetration resistance and moisture content) are available to apply to Fig. 4 for a ready identification of the soil type.

The soil type in use having been identified, the density to be obtained was also known. Grading operations then could proceed with full knowledge of what amount of rolling was required to produce satisfactory compaction, provided of course that the field moisture content of the soil was sufficiently close to the optimum. Ellipitical needle points were used regularly in the field to determine when the rolling had produced a sufficient soil density. Successful use of penetration needles for this purpose was due to the fact that all the soil types encountered were clays that contained no gravel and practically no chert.

Results found excellent

At least once each day on every active fill area, and always when as much as 2,000 cu. yd. of fill had been placed, an undisturbed sample of soil was cut out of the embankment with a ring cutter, and the dry density of this sample determined in the laboratory. In this way daily checks were obtained on the accuracy of the needle penetration resistance.

Results achieved were entirely satisfactory, and two years after construction was completed no settlement had been discovered despite thousands of level readings made on the footings. When a large addition to the plant was begun early this year, the designing engineers required that all fill be placed under the specification for controlled compaction.

Lt. Col. William P. Cornelius represented the Manhattan District for the Corps of Engineers on this project. The Kellex Corp. of New York was the architect-engineer. The J. A. Jones Construction Co., Inc., of Charlotte, N. C., was the general contractor, H. V. Appen being project manager, A. C. Samford, general superintendent and John D. Watson, chief engineer. O. R. Bradley, as soils engineer, directed all field testing and placing of fill. The grading subcontractors were Oman-Creighton, Nashville, Tenn., Wolfe-Michael Construction Co., St. Augustine, Fla., and the D. W. Winkelman Co., Syracuse, N. Y.

Surveying for Fast Construction

Howard R. Kornberg
Construction Engineer, J. A. Jones Construction Co. Inc.

THE SIZE of the main building and the speed of the work made the field engineering layout for the gaseous diffusion plant at Clinton Engineer Works a major problem in itself. Though the main building appears to be a single "U"-shaped structure, actually it is composed of a large number of separate building units. A single roof covers the whole group, but between every adjoining unit there is a multitude of piping interconnections. This type of construction necessitated a unique, and somewhat complicated, layout in order that the separate units could ultimately be tied together to form a single unified process plant.

To accomplish this result a primary base line was established away from the building site, where there was no possibility of disturbance, and secondary base lines were run inside the building site, and parallel to the primary base line. The primary base line was run 9 ft. off the center line of the construction railroad main line, and was 2,600 ft. long. A concrete monument was set at each end, and intermediate concrete monuments were placed at about 500-ft. intervals. The secondary base lines, run inside the building site, were offset 1 ft. from the center of column line No. 3.

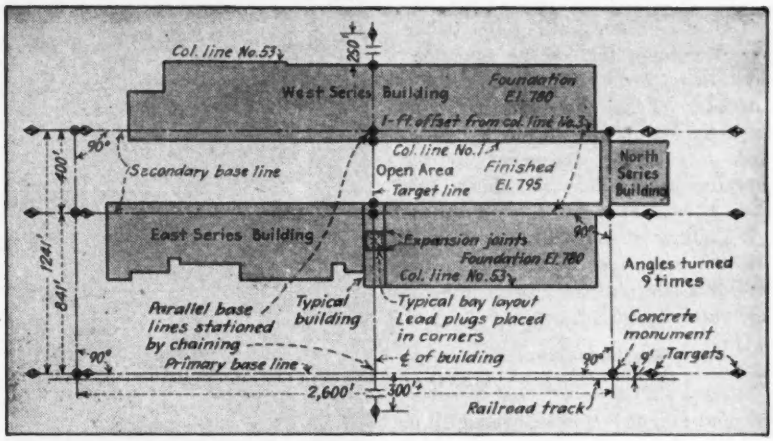
Two targets were set up on each end of each base line. One target was set completely off the building

site where there was no danger of its being disturbed. A second target was placed on the building site, to be used in case visibility became poor on account of darkness or fog. Every target had its description clearly painted in large letters on a board directly under the target. In this way the instrument man always was able to identify the target through the telescope, and the possibility of error due to reading the wrong target was largely eliminated. The targets used were 4 ft. square and were painted red and white in alternate triangles. Such a target is quite satisfactory for a 2,000-ft. foresight.

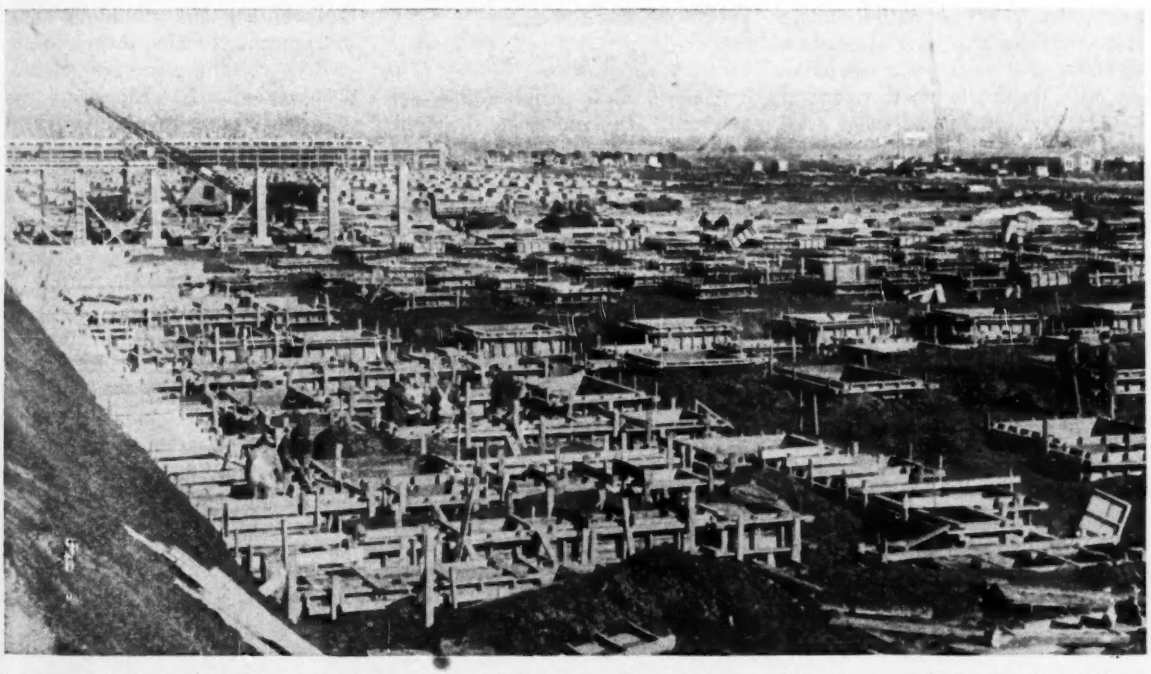
In establishing the secondary base lines the 90-deg. angles were turned at least nine times and averaged to insure the accuracy of the rectangle. Once these rectangles had been established and checked, it was possible to layout any building for any desired order of construction. Actually, the sequence of construction was very irregular, and this type of layout was very necessary. The primary and secondary base lines were laid out while grading operations were in progress, and it was impossible to establish all corners permanently until the grading was complete.

Each building unit is composed of a basement and first floor of monolithic reinforced concrete. The second and third stories are framed with structural steel. The footings were poured directly on top of undisturbed soil in the cut sections, and on top of compacted fill in the embankment sections. The ground elevation inside the "U" was the same as the top of the first floor slab, and this high level of ground was maintained by a reinforced concrete retaining wall located between column line Nos. 2 and 3, very close to the secondary base lines which were on the basement floor level.

The center line for one building unit (see layout sketch) was run from the primary base line to a concrete monument located at the lower, or basement floor, level along the outside wall (Col. Line No. 53 for the east series of buildings). This monument was the established point from which all east series footings were located. Then the building center line was extended to a concrete monument on the secondary base line. Subsequently, center lines for all other buildings on the east series were established by precise chaining, north or south along the secondary base line.



Base line and target layout for accurately locating points over a 60-acre building.



A two-man instrument party was required for each 500 construction workers on the gaseous diffusion plant at Clinton Engineer Works. Shown here are footing and column forms for the main building.

Another concrete monument was set on the building center line at the No. 1 column line on the upper, or first floor, level inside the "U" on the east. From this point an intermediate set-up was made to establish a concrete monument on the building center line at column line No. 1 for the western side of the "U". Targets were then established on the east and west, outside the building site on the center line for the single building unit.

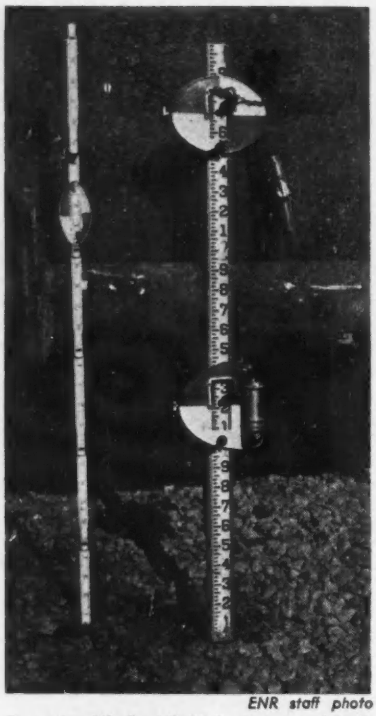
Machinery layouts

Each building unit (width between 50 and 200 ft.) was separated from the adjoining units by expansion joints, and transverse expansion joints were located about 75 ft. apart. Most of the building units are nearly 400 ft. long, and consequently there was considerable movement in the structure due to temperature changes. No attempt was made to make machinery or piping layouts until after a building was under roof, as this tended to reduce the temperature fluctuations and decreased the amount of movement.

After the structural steel for a building was erected and plumbed, the building center line was projected on all floors. Lead plugs were placed in the concrete slab of the first floor and punch marks were made in the steel. This true center line, established separately for each building unit, provided for any variations occurring in the location of one building with respect to another, and it also gave all crafts and subcontractors a common starting point. With all piping and equipment tied together from floor-to-floor, as well as from building-to-building, this common control was very essential. Tolerances in grade were limited to 0.005 ft., and line variations to 1/16 in. plus or minus.

Accurate rectangle established

After a building was under roof, a layout rectangle was established on the first floor slab for each bay. Lead plugs were set in the concrete for the corners and from these centers all equipment was located. Each line was marked, and the layout pattern was typical, so that any man could go into any building and know where to begin. In locations where points on the floor would be covered by equipment, pads were welded to the under side of the structural steel beams so that plumb bobs could be hung from the ceiling.



ENR staff photo

Target with flashlight battery and bulb to throw light on vernier is displayed on a cut-off level rod. At left a 6-ft. rule and plumb bob target have been converted to a level rod, with vernier added for reasonably accurate readings. Both devices were developed on the job by S. S. Chappell.

Lighted level rod

A new level, in perfect adjustment, was reserved for the establishment of all bench marks. Bench mark levelling was done only after work hours in order to avoid vibrations caused by construction equipment. For ease in handling inside the buildings standard level rods were cut off to convenient lengths. On these rods a one cell battery and flashlight bulb was mounted on the rod target to permit accurate readings in poorly lighted corners. Some levels were equipped with similar lights to facilitate adjustments of the bubble tube.

In the basement and on the first floor two types of benchmarks were established. A painted scribe mark was made on every other column about 1 ft. above the floor. In strategic, but out of the way, locations a ¼-in. bolt was put in the wet concrete of the floor slab, and left protruding about 1 in. for all elevations requiring any refinement, since the scribe marks on the columns were scarcely good to more than 0.01 ft. Above the first floor all elevations not requiring an accuracy greater than ⅛ in., were taken directly from the structural steel framework.

Personnel requirements fluctuated in accordance with the types of work underway but at no time was it possible to employ experienced rodmen since the young men who usually do this work were all in the army.

As far as possible, instrument parties were given repetitive assignments so that they became proficient on one operation and followed it through the entire job. For example, two parties started on the layout of footings. By the time footings for 20 buildings had been placed, the men had become so proficient in the task that one party could do all the work.

For layout inside the buildings it was found that a two-man party could work very successfully. These two-man parties carried both a transit and a level so that they could switch momentarily from line to grade. With this system one experienced field engineer was required at the peak of the construction period for every 250 construction workers, to establish and maintain the layout for all buildings, roads, utilities and subcontract work.

One man was held responsible for the accuracy and condition of all instruments, checking them systematically for adjustment and cleaning them periodically. Tapes and level rods were replaced frequently to avoid errors caused by misreading defaced numerals.

Usable ideas developed

During the progress of the work the men were alert to invent and develop ways and means to improve or simplify the particular job they were doing. It was learned that worn-out triangular saw files, contributed by the carpenters and ground flat on one end, make an ideal tool for putting scribe marks on concrete. Shoe polish paste is an excellent paint substitute for stencilling numbers on concrete columns. For marking on floors that will be covered with dirt red paint is more easily seen than white. A converted plumb bob target mounted on a 6-ft. rule made a convenient rod for checking elevations in cramped places.

Building a City from Scratch

Ernest A. Wende
Engineer, U. S. Engineer Office, Oak Ridge, Tenn.

Prime considerations in planning and building the housing development necessary to construction and operation of the Clinton Engineer Works were speed, saving of critical materials and minimum interference with the local labor supply. These requirements were met by adapting surplus materials and housing from other war projects, by laying out the town on contour-planning principles, and by eliminating much on-site labor through simplification of design and by prefabrication at localities well removed from the construction site. All of these expedients proved highly effective.

DURING THE SHORT SPAN of two and one-half years, the full fledged city of Oak Ridge mushroomed from the sparsely populated farm land of Eastern Tennessee. Highly publicized as the "Home of the Atomic Bomb," this community was constructed as an incidental by-product of the largest and one of the most effective projects for war. With its population of nearly 75,000, making it the fifth largest city in Tennessee, the new community has nearly 10,000 family dwelling units, 13,000 dormitory spaces, 5,000 trailers and more than 16,000 hutment and barracks accommodations, together with all of the supplementary facilities that make up a complete and integrated municipality.

Oak Ridge is the residential center for the Clinton Engineer Works. It is also the administrative center for the entire Manhattan District, which includes the Hanford Engineer Works near Pasco, Wash., and numerous other installations. The site, a hilly and wooded section 1½ mi. wide and 6¾ mi. long in the northeast corner of the 59,000-acre government reservation, was selected to provide a reasonable separation from the plant areas of the Clinton Engineer Works and to create a desirable housing development.

Much of the town was laid out with rear entrances toward the street and with porches and main entrances facing spacious grassed and wooded areas. Over the greater part of the town the raw scars of construction have now been covered by resident-created lawns and gardens, with the result that the community has a permanent and pleasing aspect.

As Architect-Engineer-Manager for all of the early construction at Clinton Engineer Works, Stone & Webster Engineering Corp. was assigned the job of providing living quarters for personnel necessary to plant operation. This phase of the development was turned over to the architectural firm of Skidmore, Owings and Merrill, of Chicago and New York which prepared building plans and town layout based on housing designs developed by the John B. Pierce Foundation. The A-E-M firm, however, was responsible for coordination of the work, procurement of materials, con-

Winding roads and contour location characterize Oak Ridge, Tenn., built in 2½ years to house 75,000 people.

Attractive living quarters, such as this 3-bedroom house, help to hold hard-to-get top personnel.

tract supervision and construction of roads and utilities.

After this relatively normal beginning the town passed through three principal phases of expansion, telescoping the normal growth of a century into only 2½ years. As a result the city's present area is nearly double that included in the first plans.

Roads and utilities

The main roads of Oak Ridge follow contours on the ridge, with frequent connections to the valley by thoroughfares following winding routes along natural grades. "Avenues," usually named for states, connect the valley with the ridge, "drives" parallel the ridge; "roads" are short secondary loops stemming from avenues; "circles" as the name implies, come back out on the same route; while "lanes" are dead-end. All secondary streets have names starting with the same letter as the avenue to which they connect and are in alphabetical order starting from the valley. Thus, it is relatively easy to find one's way through a strange area on the winding roads.

Little cut and fill for streets

Streets are all 30 to 40 ft. wide, including shoulders, and generally follow the surface of the ground, average cut and fill being 1.3 ft. This required grades up to 12 percent (few sections are more than 8 percent), but it reduced substantially the time required for construction.

The avenues are paved with a bituminous surface treatment, but secondary streets, with few exceptions, are surfaced only with crushed stone. Drainage is by side ditches, with only a few hundred yards of curb and gutter along the 100 mi. of road in Oak Ridge.

Water lines, which follow the streets, are laid about 3 ft. deep and 1 ft. inside one edge of the road metal, where they can be reached without closing the road. Sewers generally are laid behind the houses and follow minor valleys to the trunks. There are some crushed stone sidewalks in Oak Ridge, but the only concrete ones are some short lengths in two of the main shopping centers.

A minimum of utility installation was made throughout the area. While electricity is used for cooking, none of the services is metered and telephone lines, limited to essential personnel only, are carried on the same poles as electric lines.

The architects were retained in February, 1943; in March, work started on the first 1,000 houses; and by August the first phase of the building program was all under contract in what later came to be known as "East Town". This included the construction of 3,050 family dwelling units ranging from 1-bedroom apartments to 3-bedroom houses, three "efficiency" apartments buildings, seventeen 150-man dormitories, a commercial area, a 50-bed hospital, four schools and other essential community facilities. The last units of the first group were completed during May, 1944, roads, utilities and miscellaneous buildings having kept pace with the rapid growth of the town.

In general, living facilities provided at Clinton Engineer Works are the minimum consistent with getting people to come to the project and stay there. In like manner, administrative and commercial buildings are of "five-year" construction with no frills.

In designing the first group of houses a prime consideration was the minimum use of critical materials such as lumber, copper and steel as well as minimum demands for labor on the site. An unusual feature of the design, to achieve the minimum of on-site labor, was the use of prefabricated panels consisting of a thick layer of fiber board with ¼ in. of asbestos-cement bonded to both sides. Panels are fitted into slotted 4x4-in. posts and provide a complete interior and exterior wall in a single section.

Contracts by 1,000-house units

Contracts were let in units of 1,000 houses to permit assembly line construction technique. Lumber was precut and light roof trusses assembled at central mills on the area to minimize the use of hand tools. The wall construction described resulted in use of casement windows and screens sized to conform with standard panel widths, thereby involving a minimum of cutting and fitting. The roof consisted of lapped sections of insulation board encased in 90-lb. mineral-surfaced roofing. Thus, sheathing, roofing and insulation were provided in a single rapidly-laid unit.

For the four schools built under the initial program similar construction combined with brick resulted in modern and attractive structures. "H" type dormitories and other miscellaneous structures were designed by Stone & Webster Engineering Corp.

and are of conventional frame construction.

The second phase of the town construction program, largely built at a new "West Village," was primarily a low-cost housing development consisting of 4,800 family quarters, 52 dormitories, schools, cafeterias and supplemental buildings. The Tennessee Valley Authority, to provide temporary housing for construction workers, had developed a 1-, 2- or 3-bedroom "trailer house." This house could be purchased assembled in 2, 3 or 4 sections and moved on trucks to the job for final assembly with a minimum of on-site labor. TVA cooperated in making plans available, and the type was adopted with very little modification for 2,600 of the units.

Site assembly in 8 hr.

One of these dwelling units could be assembled ready for occupancy in about 8 hr. Post foundations proved to be inexpensive and rapidly constructed. Use of plywood for interior and exterior walls provided sufficient additional strength so that light 2-in. framing could be used throughout the structure. Other important features of these units included careful space utilization and the use of some built-in furniture.

Another 1,000 dwelling units were transferred from other war plants where they had been provided by the Federal Housing Authority but were no longer needed. These stove-heated buildings, of frame construction on post foundations, contained either two- or four-family units. Of panel construction, this type of structure is considerably more expensive to assemble than the TVA type, but is less costly to transport because more compact packing is possible.

On the second phase of the town construction program Skidmore, Owings and Merrill laid out the addition and designed the houses and utility systems, while Stone & Webster let and supervised the construction contracts. On a third phase of construction, made necessary as plants continued to expand, the architectural firm worked as prime contractor on design and supervision of construction contracts, which were let directly by the Manhattan District.

For the latter work, early in 1945, 20 dormitories and another 1,000 TVA-type houses were authorized as well as 1,000 marginal-type units designed to provide the absolute minimum in family accommodations. The latter consisted of a 1-story, 2-family dwelling 20x28 ft. in size constructed of light plywood panels and supported by 4-in. posts. Windows, without hardware or counter weights, drop into wall recesses.

This last construction program was about half completed when news of the Japanese surrender resulted in a partial cutback.

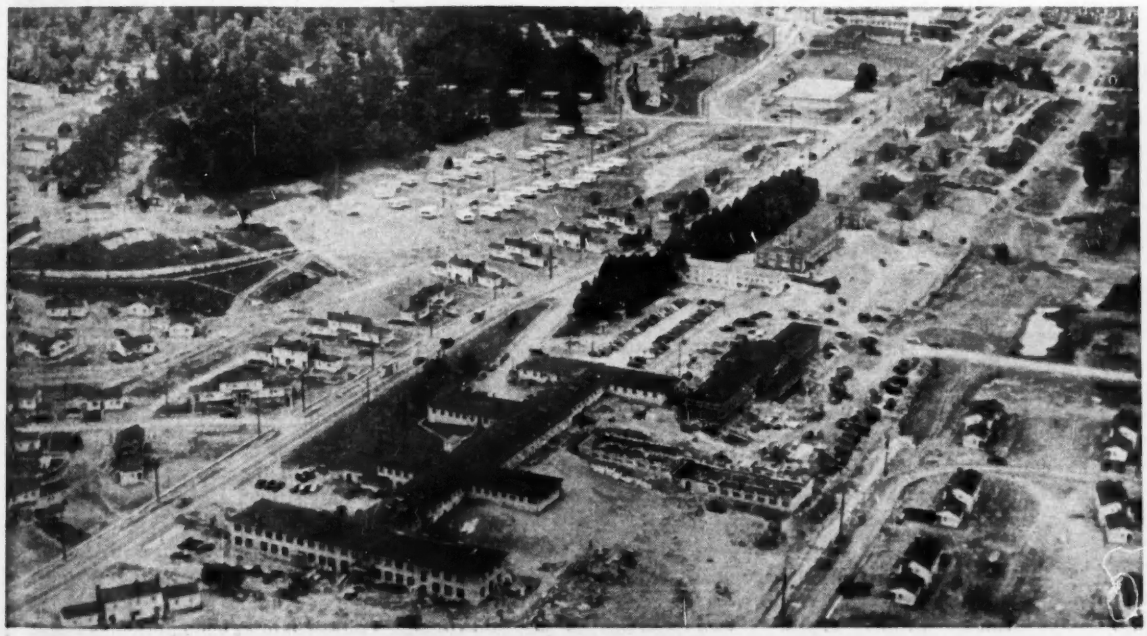
City managed on fixed-fee basis

Oak Ridge is operated as a military reservation governed by the commanding officer, in this case Col. Nichols, the district engineer. There is no mayor, but a voice in the administration on the part of the people is afforded by an advisory committee. For operation, the functions of a public utilities department have been carried on by an organization formed by Turner Construction Co. and known as Roane-Anderson, named after the two counties in which Clinton Engineer Works is situated.

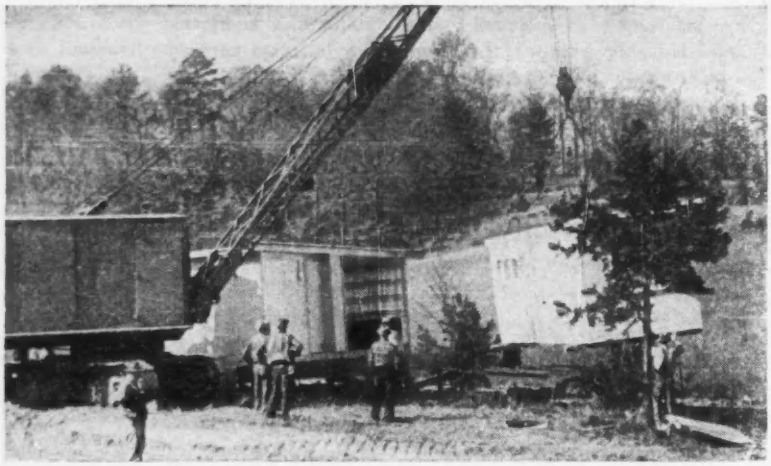
Until recently Roane-Anderson operated the entire town with its own forces. Included in its scope were rental and upkeep of houses and dormitories, operation of the cafeterias, buses, fire and police service, garbage collection and the like. The service was handled like other fixed-fee contracts on the project.

Now, many of the services, such as operation of the dormitories, houses, cafeterias, buses, refuse collection, ice delivery, coal delivery and some building maintenance, are being contracted on a lump-sum or unit-price basis to firms specializing in these functions.

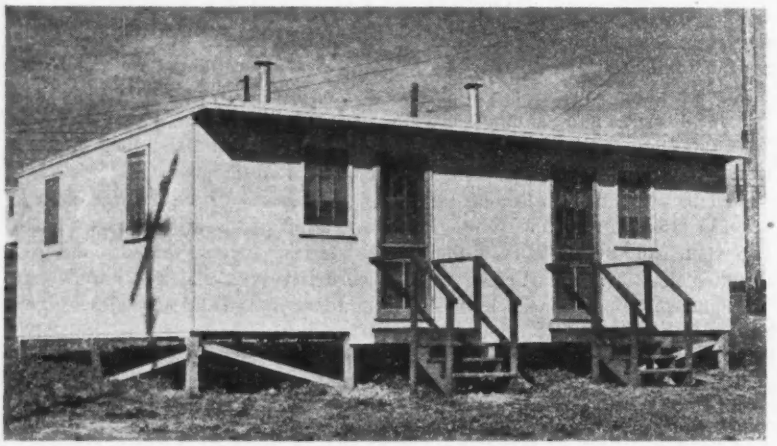
Development of several large con-



Several types of housing are grouped around the hospital, here seen getting its second addition.



TVA-type house is assembled into sections at locations sometimes as far distant from site as 650 miles, and transported by trailer or on temporary wheels to site, where a few men put a two- to four-unit house together in one day.



Marginal-type house accommodates two families in a 20 x 28-ft. structure.

struction camps paralleled the growth of the new city. During the summer of 1943, some 1,000 trailers were brought in. To serve them, laundry and toilet buildings were constructed, together with roads, walks and utilities.

At the same time, an equal number of 16-ft. square, unlined plywood huts were erected to house 5,000 construction workers, and later, a quantity of 20x100-ft. plywood barracks were purchased and set up. By the summer of 1945, the number of trailers had increased to 5,000, and three large hutment camps contained 2,500 huts. In addition, 90 barracks and 6 temporary dormitories had been erected.

Incidental to the above was the construction of several large cafeterias, three of which can serve 10,000 meals per day each, recreation halls, warehouses, churches, athletic fields and other facilities essential in any normal community. A population peak of approximately 32,000 was reached in the several construction camps during the summer of 1944. Stone & Webster Engineering Corp. and the J. A. Jones Construction Co. were responsible for the construction of the majority of these facilities.

Supplementary community facilities

Nine schools, with capacities ranging from 350 to over 2,000 have been built. They are single-story, except the high school, and the majority of the buildings are composed of weather-proof insulation board on standard wood frame or prefabricated panels in a skeleton frame of posts and girders.

Two large laundries, a cold storage building and two large groups of warehouses provide service facilities to the city. The Oak Ridge Hospital, designed originally for 50 beds, has been expanded to a multi-winged structure about 650 ft. long and containing 300 beds. It is mostly of concrete block construction.

Two main shopping centers were developed in the town in addition to numerous neighborhood store groups. Designers of both centers took advantage of favorable topography in providing service entrances at basement floor levels with customer access at the first floor.

One of these shopping centers, known as "Grove Center," is noteworthy for the use of corrugated asbestos board for exterior finish providing attractive and modern fire resistant buildings at low cost. With the advantage of pre-planning, sufficient parking space was obtained convenient to the stores, thus eliminating disadvantages inherent in most city commercial areas.

Many recreation facilities

Because of the large proportion of dormitory and construction camp residents, as well as the great number of younger children natural to a city composed almost entirely of young and middle aged couples, numerous recreation facilities were essential to prevent a large labor turnover.

Community houses were constructed in the trailer camps and several recreation buildings and bowling alleys were built. Two roller skating rinks are in operation, as well as many soft ball diamonds, two base ball diamonds, 22 tennis courts, badminton courts, seven theatres, a library and similar facilities for adult recreation.

Dozens of playgrounds, for teenage children as well as tots, were constructed in the town and trailer camps. These playgrounds are supervised by a community organization. In trailer camps, where living conditions were least comfortable, extra facilities were provided in the form of wading pools. In addition, a concrete outdoor swimming pool was constructed near the center of the city. This pool is large enough for a 100-meter straightaway race course.

Much of the expense of this recreation program, including the cost of the swimming pool, was borne by a self-sustaining commuity organization set up for the purpose.

Water Supply and Sewage Works For the Atomic Bomb City

G. E. Crosby
Resident Engineer

P. B. Streander
Industrial Engineer

Stone & Webster Engineering Corp.

● *"Explosive" growth of the complete new city of Oak Ridge, Tenn., compressed into 2½ years problems of utility design and construction ordinarily spread over a century. How the city's water supply developed from its tank-wagon start to a modern 16-mgd. service, and how two complete sewage systems were built to handle flow from the 75,000 population are described in the following.*

DESIGN AND CONSTRUCTION of the various utilities for the Clinton Engineer Works and its tributary city of Oak Ridge are of unusual interest to municipal engineers because of problems involved in keeping pace with the demands of the rapidly increasing population and production facilities. When the project was started it was estimated that a townsite to accommodate 5,000 would meet the housing requirements. The actual, ultimate population served was nearly 75,000.

The Clinton Engineer Works, in which Oak Ridge is situated, is located in the foothills of the Cumberland Mountain Range. The town is bounded on one side by Black Oak Ridge, at El. 1,150, and on the opposite side by Oak Ridge Turnpike, at El. 850. The residential section lies on a hill extending from the crest to the lower valley areas, where are located the business sections, trailer camps, dormitories and hutment areas. A saddle divides the town into two areas, one draining toward the Clinch River at the east and the other sloping toward Poplar Creek at the west. Served from the same utility systems is the plant for electromagnetic separation of uranium isotopes which is located in a separate valley about two miles south of the town, beyond intervening protective ridges. Stone & Webster Engineering Corp., Architect-Engineer-Manager both for this plant and for the town of Oak Ridge, built the utilities with its own forces.

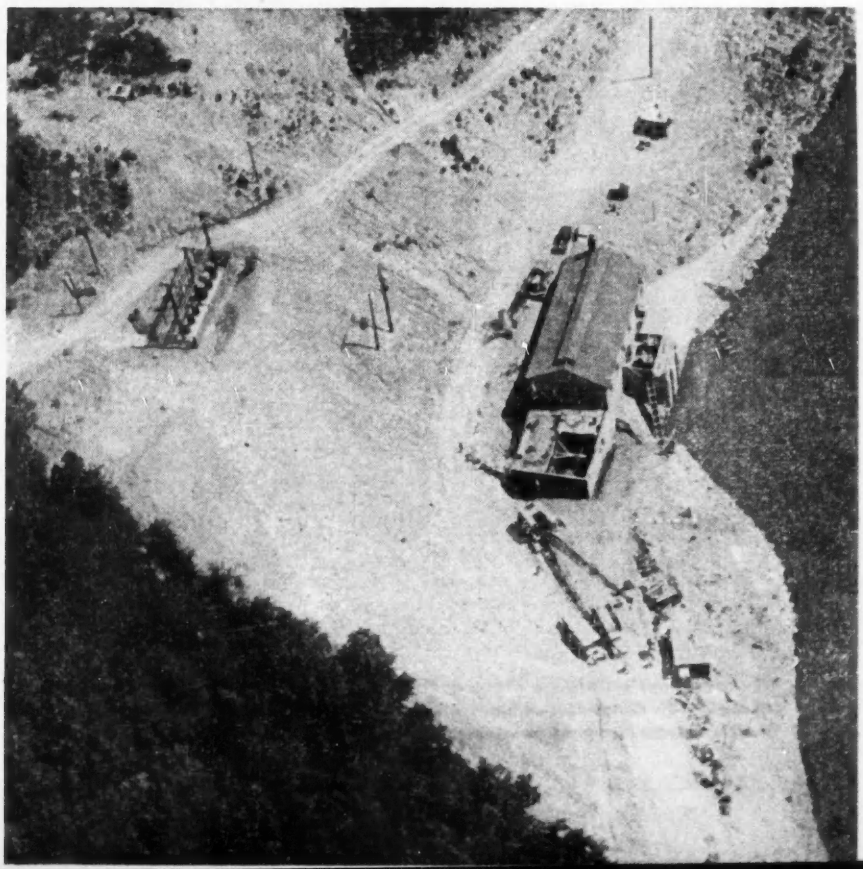
Utilities for the town and the plant area were designed and constructed in five distinct stages, as follows:

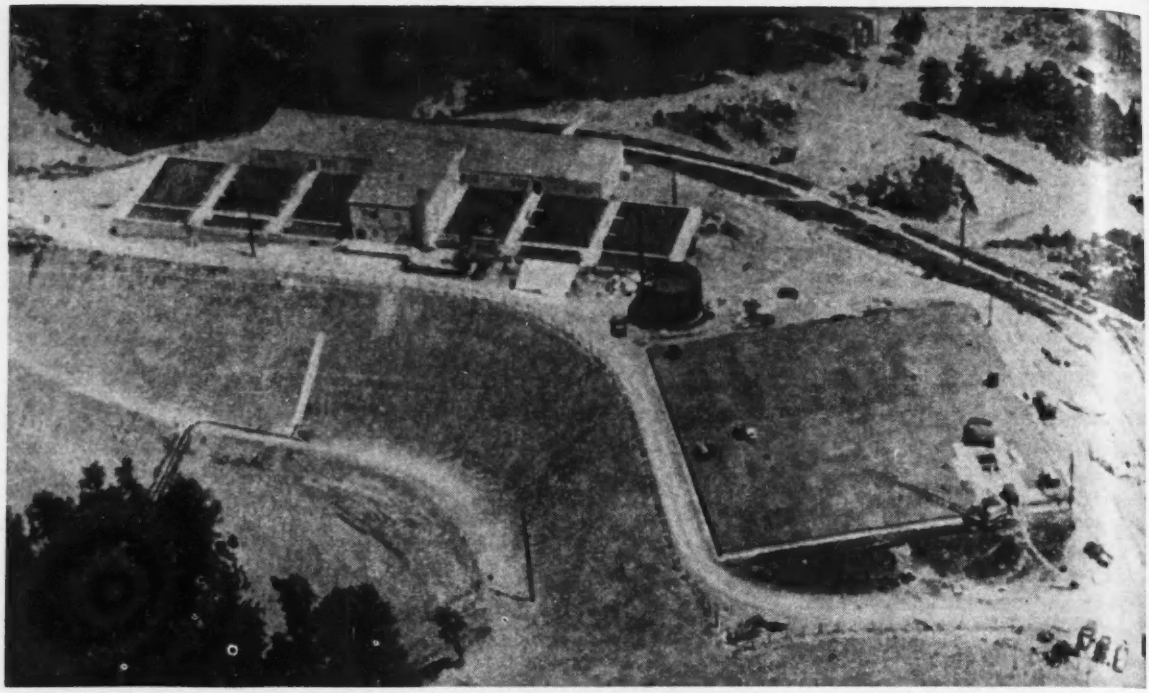
1. Temporary water supply and sewerage for construction and administrative personnel during the early construction period.
2. Central townsite and original production area.
3. East village and expansion of original production area.
4. West village and new production area extension.
5. Final development of Oak Ridge and the production areas.

In this development the population increased from the original estimate of 5,000, first to 22,000, then to 38,000, followed by 65,000 and, ultimately, 75,000. Manufacturing facilities increased in about the same ratio. As a result, one plan was hardly developed and construction work started before changed requirements dictated the necessity of an entirely new layout.

The relentless demands of the rush

Location of 28-mgd. pump house on steep bank of Clinch River imposed considerable difficulty in anchoring two 24-in. force mains.



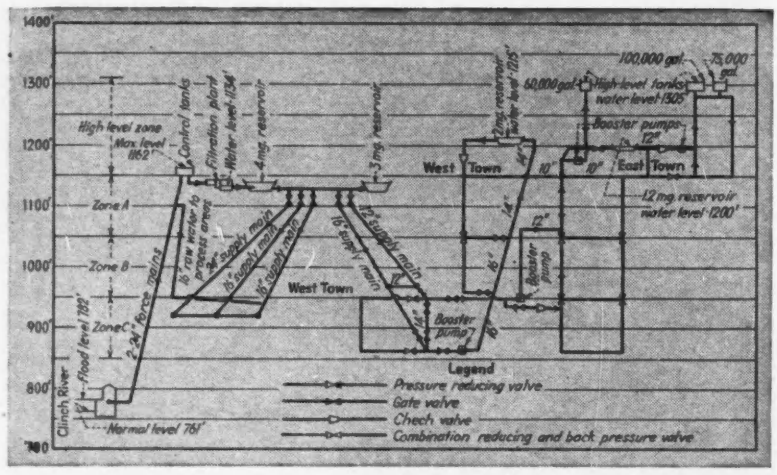


Filtration plant of 16-mgd. capacity is located 300 ft. above and 14,000 ft. away from supply source. Square at right is top of 4-mg. distribution reservoir, which is divided into two compartments.

construction schedule required great ingenuity and the utmost coordination of the various construction divisions and subcontractors in order that all phases of the work could be carried on without interruption. As a result, between March 24, 1943 and Aug. 1, 1944, when houses were being released for beneficial occupancy on an average of 16 a day, the 550 mi. of sewer and water lines were being installed at the rate of 600 ft. per hr., or nearly a mile per 8-hr. work day.

During initial construction and before there were living facilities on the project, water was hauled by tank wagons from Clinton, seven miles away. As quickly as possible, a temporary water supply system was constructed to replace the ever-increasing demand on the tank wagon supply. This temporary system consisted of a small pump house at the Clinch River with a force main to a pressure filter plant. Two booster pumps were installed at the filter plant with a force main through the townsite to a 150,000-gal. wooden storage tank located on the ridge north of the town. Raw sewage dumped into the river at Clinton, about nine miles above the temporary pump house, necessitated extreme precautions in operating the plant.

Later, this temporary water supply was connected to a 1,000,000-gal. reservoir, which eventually became a part of the permanent system. This provided a continuous supply of 200,000 gpd. until the permanent water supply was functioning.



The water system at Oak Ridge is divided into three pressure levels on account of the 300-ft. differences in elevation in the town area. A large volume of cooling water is taken from raw-water force main.

High-level filtration plant

The permanent water supply system consists of a pump house located on the Clinch River, with force mains to a filtration plant and reservoirs located on a ridge between the production and townsite areas. These reservoirs supply the entire manufacturing area and the lower levels of the townsite by gravity. Booster pumps and high-level storage reservoirs serve high areas of the town.

Originally the pump house contained four centrifugal pumps having a combined capacity of about 12 mgd. Later the pump house was extended to house four more pumps, increasing its total capacity to about 28 mgd. Each pump discharge is provided with

an automatically operated cone check valve and surge anticipator.

The pumps discharge into three separator manifolds connected to the force mains leading to the filtration plant. The force main installation consisted originally of about 14,000 ft. of 24-in. C.I. pipe, and subsequently was increased by a second pipeline of the same diameter and length. The two force mains are interconnected at three points and provided with sectionalizing valves.

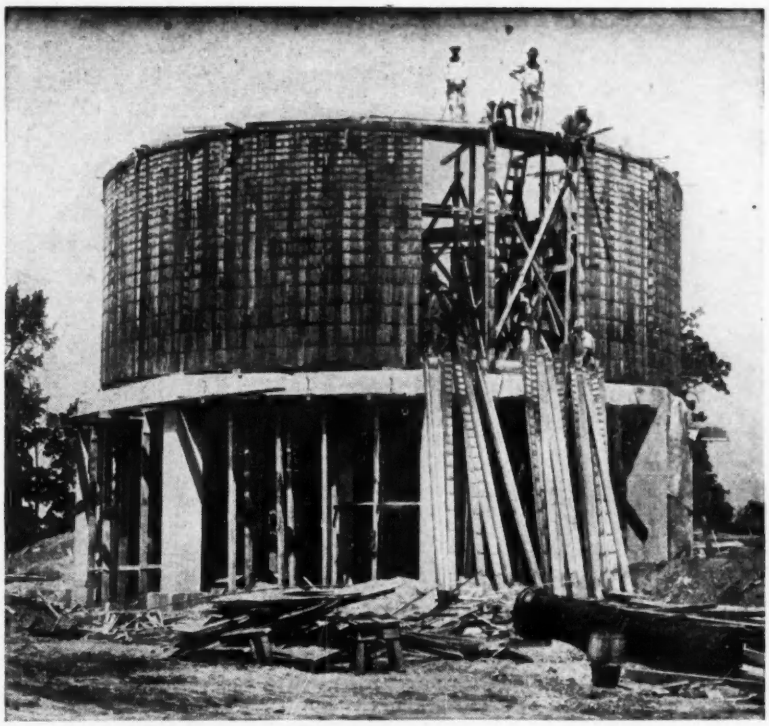
Built to a capacity of 9 mgd. originally, the filtration plant was later enlarged to 16 mgd. Of the conventional type, it consists of a flash mixer; two flocculation tanks equipped with mechanically operated paddle mixers; two settling tanks; and 14 gravity-type filter units of concrete. Equipment for feeding aluminum sulphate and hydrated lime to the raw water, and soda-ash to the filtered water for pH control, is of the automatically-operated, gravimetric type. Facilities are provided for pre- and post-chlorination. The filters are back washed by means of motor-operated centrifugal pumps and are equipped with surface-type sand washers and the customary gages.

Alongside of the filtration plant are a 4-mg. reservoir, divided into two compartments, and another distribution reservoir of 3-mg. capacity. Two 16-in. feed lines, originally installed to supply the manufacturing area from these reservoirs, were later supplemented by an additional 24-in. line. These supply lines tie into the distribution system at three points, thereby securing more constant pressure throughout the area.

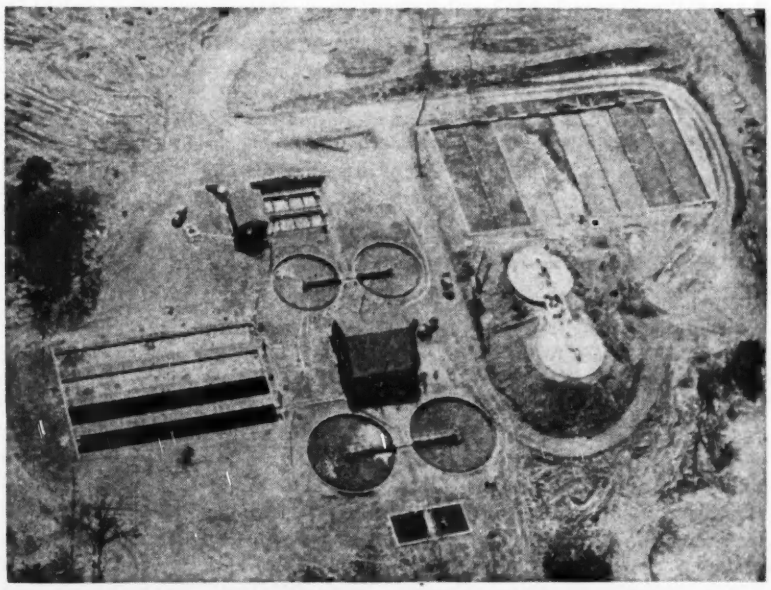
Three pressure zones

A 12-in. supply main was originally constructed from the 4-mg. reservoir to serve as a gravity supply to the lower levels of the townsite, and an automatically-operated booster pump installation forced water to a high-level 1.2 mg. reservoir located on Black Oak Ridge at the northerly side of the town to supply the high and intermediate zones. Later, an additional 16-in. supply main was extended from the reservoir to the west townsite, with automatically-operated booster pumps to force water to a second high-level reservoir of 2-mg. capacity.

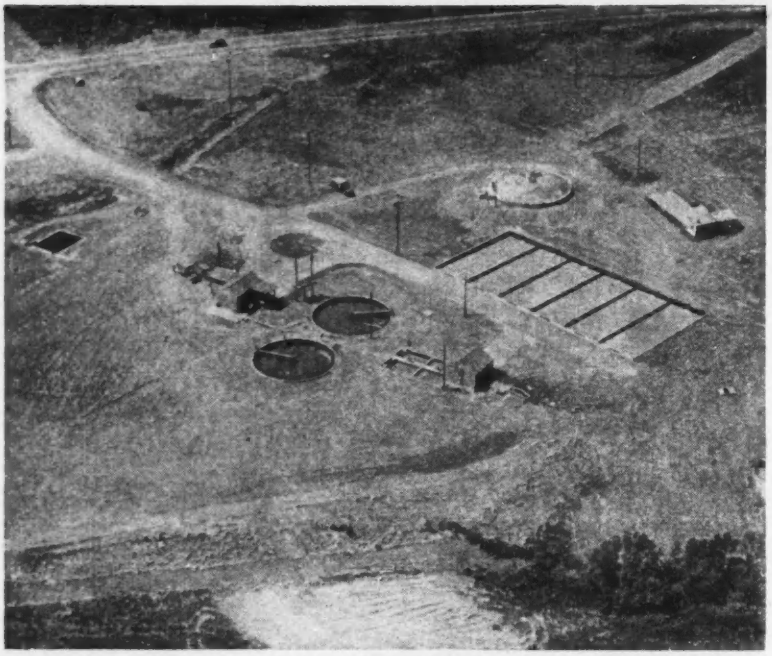
With a difference of almost 300 ft. between the high and low levels of the town, it was necessary to divide the distribution system into three pressure zones. This was done by installing automatic pressure reducing and regulating valves at the zone intersection points. Specially designed control valves are utilized at the two booster-pump houses to cut off automatically the flow to the low-level zone during periods of extreme demand,



To serve high areas of the town, elevated storage tanks are supplied by booster pumping stations. This redwood tank was obtained second-hand and re-erected with the staves opposite end up from the original installation.



Easterly sewage treatment plant uses activated sludge process to treat 2 mgd. Plant effluent has lower biochemical oxygen demand than the receiving waterway, from which water supply is taken further downstream.



Westerly sewage plant provides primary treatment and chlorination. Present flows of 4.5 to 6 mgd. overtax design capacity of 3.5 mgd., reducing expected treatment results. Plans call for providing chemical precipitation.

thus assuring an adequate supply to the booster pumps. During such periods the low-level zone was supplied from the high-level storage reservoirs through pressure regulating valves in the high and intermediate zones.

An uninterrupted supply of water was assured at all times by interconnecting supply mains to the booster pumps in low-pressure zones, and cross-connecting distribution mains.

Plant process water

Make-up water for a cooling tower installation, reputed to be the largest in operation at the present time, constitutes a large part of the water demand for the manufacturing area. Most of this is raw water taken directly from the force mains between the river pump house and the filtration plant. Both raw and filtered water are chemically treated to prevent scaling.

Total amounts of water used on the project closely approach designed capacities, and during warm weather the raw-water pumps and the filtration plant operate at full capacity. Controls are installed at the filtration plant so that all operations can be observed at one point. All water pumped and distributed from the filter plant is metered.

Originally the permanent system, designed for a population of 12,000, was intended only to serve the east village. A trunk sewer was laid from the manufacturing area to a pumping station where sewage was pumped over the ridge between the easterly and westerly parts of the townsites. The townsite trunk sewer is 18-in. dia. and carries the sewage to the easterly treatment plant located near the Clinch River.

Later, when the manufacturing area was expanded and the west townsite was constructed, the trunk sewer from the processing plant was extended to a new sewage treatment plant built along Poplar Creek at the westerly end of the town and about seven miles from the easterly plant. At this time the pumping plant was placed in stand-by operation. All sewage from the manufacturing area and the west townsite now flows by gravity to a westerly treatment plant through a trunk sewer varying from 18 in. to 36 in. in size.

The sewer system is, therefore, divided into two separate drainage areas—one flowing to the easterly disposal plant, where the effluent discharges into Clinch River about 10 mi. above the water supply intake; the other flowing to the westerly disposal plant, where the effluent discharges into Poplar Creek at a point 16 mi. above its confluence with the Clinch River.

The easterly sewage treatment plant, having a capacity of 2 mgd., is of the activated sludge type. It consists of a grease removal tank, primary settling tanks, aeration tanks of the air-actuated spiral-flow type, secondary settling tanks, chlorine contact tanks, two-stage heated sludge digestion tanks and open sludge drying beds.

Aeration tank design

The aeration tanks are of the return flow type and are designed so that settled sewage may be applied at four points in the first passes of the tanks. Return sludge can also be supplied at four points.

With this design, sewage can be pre-aerated before sludge is added, the sludge can be reactivated, or step loading of applied sewage can be used. During the major part of the time settled sewage flows into the first pass at two points, with return sludge added at three points. Present flows through the plant average between 1.5 and 1.85 mgd.

Operating results have been excellent, the plant effluent having a lower oxygen demand than that of water in the Clinch River at the discharge point, which is nine miles below the outfall sewer of Clinton, Tenn.

The westerly sewage plant has a designed capacity of 3.5 mgd. for primary treatment only. It consists of a grease removal tank, primary settling tanks, chlorine contact tanks, a single-stage heated sludge digestion tank and open sludge drying beds.

Chemical precipitation plant needed

Due to the final expansion of the townsite, present flows average between 4.5 and 6 mgd. High peak hourly flows also occur due to three shift operation of change houses in the production area. Under these conditions, treatment results are not up to those anticipated. Plans have been made to change the plant to the chemical precipitation type, but conversion is being held in abeyance.

Although certain process wastes from the production area are discharged into the west side trunk sewer, they are, for the most part, pretreated and, therefore, present no problem to the treatment plant except that of increased flow.

CONTROLLED ATOMS or CONTROLLED LIVES

SINCE August 6th when the first atomic bomb was released over Hiroshima, the American people have been subjected to a continuous barrage of pronouncements on the use and control of atomic energy. Some of this comment has been strident, and much of it conflicting. A considerable portion of it has been of sincere and constructive excellence.

It has not been easy to separate the wise counsel from the merely noisy, and it is small wonder that the minds of many are troubled and confused.

However, the sheer mass of discussion poured into press and microphone has awakened us all to the gravity of the issue. In terms of any problem on which Americans ever have been called to exercise a judgment—This is It!

Even the dullest now recognizes that atomic weapons hang over modern civilization like the Sword of Damocles, and understands in some measure how fragile and taut is the hair of political balance that holds it suspended.

From this point on, we need the coolest and most carefully considered judgment that can be brought to bear. Discussion highly charged with emotionalism will but increase the tensions both at home and abroad, and render wholly insoluble a delicately intricate problem.

What Is The Problem?

The major outlines of that problem now are coming into focus in understandable terms:

1. The scientists have opened up a new and virtually unlimited storehouse of energy, and the engineers have discovered how to turn it into a military explosive incomparably more powerful than any we have known. We know that this energy may also be used to produce heat for useful power, and we suspect that the radioactive substances produced by the process in hitherto unimagined quantity may also have medical, industrial, and other constructive applications.

2. Terrifying as have been the demonstrations of the atomic bomb thus far, we know that they are as nothing in comparison with its potential destructiveness. The explosive force of individual bombs can be increased tremendously, and means for their effective delivery to predetermined targets in wholesale quantity already are at hand. The experts tell us that no practicable means of interception can be devised, and that reprisal in kind probably will be the only answer to an enemy attack with atomic weapons.

3. So far as we can see now, even successful retaliation would be at best an answer of hollow effect. Any two nations each having wholesale stock-piles of bombs could accomplish the practical destruction of each other. Since a first treacherous blow might well constitute an enormous advantage, a nation actuated by a ruthless urge to conquest or revenge might have the best chance of survival. But since the widest possible dispersal of bombs and launching units would be dictated by the strategy of atomic weapons, it is doubtful that one nation could destroy another without itself suffering destruction. On both sides the major centers of population could be wiped out, and the nation of least concentrated industrialization and commerce would suffer least. However, no one can be sure that the concentrated explosion of as many as 20 thousand atomic bombs would not poison the atmosphere of the world to an extent that would be fatal to great masses of population, not only within the country bombarded, but perhaps in the country which launched them.

4. The problem is further complicated because, so far as we know now, any large-scale commercial use of atomic energy as a power source is more or less inextricably linked to a potential military use. It is true that, if atomic power becomes economically feasible (which is by no means certain for a long time to come), it would require only low-grade concentrates of fissionable material, which would need further elaborate and costly processing before reaching explosive potential. But the process of producing such low-grade concentrates constitutes perhaps two-thirds of the industrial effort required to make effective bombs. It follows, then, that if nations were to equip themselves to produce large quantities of low-grade concentrates for power generation, the effort required to develop large-scale bomb production would be materially reduced. Moreover, the maintenance of an effective inspection to police agreements not to produce bombs might be forbiddingly difficult if atomic power generation were allowed.

5. In addition to the major problem posed by the use of atomic bombs in international war, any nation which produces or possesses such bombs, or the fissionable materials with which they are loaded, faces still another in the danger of their falling under the control of paranoid elements in its own population.

What Are We Going To Do About It?

We face the hard fact that we have produced a weapon capable of destroying whole nations—perhaps even the whole world. Although we were importantly aided in its development by the nationals of other countries, we, together with Great Britain and Canada, now must take the initiative in deciding what shall be done with it. We have only two choices. We can try to keep this weapon as a monopoly of our own, or we can try to place it under broad international control.

Can We Keep It To Ourselves?

If we know one certain fact about the atomic bomb, it is that it cannot long be held as a monopoly of those nations which produced it.

If Nazi Germany had succeeded in developing the weapon first, it probably would have attempted to achieve world dominion, with utter destruction as an alternative. Such a course is not within our range of choice. It violates every principle for which we stand.

Much reckless nonsense has been uttered concerning the inability of other nations to master the scientific, engineering, and industrial problems involved. It is the virtually unanimous opinion of those who worked on the project that several nations today are fully equipped in science, engineering, and industrial organization to produce atomic bombs and to provide the means for launching them. At least one of these nations, Russia, has also access to an ample supply of the necessary raw materials. The only debate is over whether it would take three, or five, or ten years for her to marshal her resources to produce bombs in multiple thousands. Once such an atomic race were on, we have no reason to believe that Russia might not divert more resources to the task than we ourselves should be willing to put into it.

Additional nonsense is talked as to how we might attempt to cope with the problem of living in a world in which mutually suspicious or hostile nations faced each other, with stores of atomic weapons on both sides. We hear talk of dispersing our cities and even of moving underground. No one has seriously reckoned the difficulty or the cost of following such counsel of despair. Still less has anyone appraised the neurotic effect upon men's minds of living by any such preposterous formula, under continuously mounting tension day after day, and year after year.

Certainly, if we could find no way to prevent the competitive production of atomic weapons, we should be driven at least to the selective dispersion of our bomb-launching facilities, of certain key industrial establishments, and of our centers of government and governing personnel. We should be forced, also, to change our traditional requirement that only Congress can commit us to active war. We should be forced to organize ourselves as a police or military state, with our scientists regimented and muzzled, with all of us under constant surveillance against the smuggling and planting of time-bombs, and constantly alerted against attack through the air.

Before we commit ourselves to any such intolerable procedure, we should be mad not to explore all possible means for making it unnecessary.

The Only Feasible Alternative Is Effective International Control

This cardinal principle has been recognized in the statement of November 15th, issued jointly by President Truman, and Prime Ministers Attlee and King. Their statement frankly concedes that against atomic weapons there can be no adequate military defense, that no nation can command a monopoly of such weapons, that responsibility for eliminating atomic energy as an instrument of war and for devising safeguards over its use for the advancement of science and other peaceful and humanitarian ends rests upon the civilized nations of the world.

They propose that a commission be set up at once under the United Nations Organization to make recommendations: (a) for extending between all nations the exchange of basic scientific information for peaceful ends, (b) for control of atomic energy to the extent necessary to ensure its use only for peaceful purposes, (c) for the elimination from national armaments of atomic weapons and of all other major weapons adaptable to mass destruction, and (d) for effective safeguards by way of inspection and other means to protect complying states against the hazards of violations and evasions.

Already criticism is leveled at the wording of the statement, at alleged omissions, at the wisdom of choosing the United Nations Organization as the medium through which to seek agreement in view of the weaknesses of the UNO Charter.

None of these issues should be crucially important. What matters is that an invitation has been issued in good faith for the nations of the world to meet and decide upon means for assuring the elimination of weapons the existence of which no one can afford to tolerate.

The decision cannot be other than international; it will require the best thought of the best brains the world can muster. The smaller nations have an equal stake with the large, and from them may well come the most fruitful suggestions. But Russia now holds the key to the success or failure of our proposal. If she accepts our invitation, no other nation will refuse.

Alternatively, there will be an international armament race paced by atomic weapons. It will mean an end of free science, a severe policing and regimentation of international travel and trade, and innumerable restrictions upon those individual freedoms which we have just fought so desperately to preserve. This is the dismal prospect if we fail to arrive at a genuinely international accord on the control of atomic energy. But even this interval would promise to last only for an uneasy period, until someone started pressing the push-buttons on the panel-boards of extinction.

The only permanent solution lies in finding means to eliminate war itself. That we cannot hope to achieve overnight, but we can, and do hope that the nations will now agree to eliminate atomic weapons and their radioactive by-products as instruments of war.

If they do that, we can move forward more surely to the constructive development of the incalculably valuable resources that science has newly opened to our use. And, we can hope also for a progressive improvement in international understanding.

Unless the nations can reach agreement on this paramount issue of atomic energy, it is difficult to conceive of any vital issue on which they might agree.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Co., Inc.

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Pumping Plant and Earthwork Milk River Project, Montana

OWNER: Bureau of Reclamation, United States Department of the Interior, Malta, Montana. Mr. H. W. Genger, superintendent.

PROJECT: Construction of the pumping plant including all required excavation, backfill and grading; the complete construction of a reinforced concrete pumping plant structure; construction of two 28 in. inside-diameter steel pipe discharge lines; the installation of one pumping unit and a three-ton, hand operated hoist and trolley, plus the installation of all electrical equipment and accessories. Work on the canals and laterals including the earthwork and structures between the Dodson North canal and the pumping plant; the canal beyond the pumping plant; the laterals from the canal; and the channel change and dike for the control of Dodson Creek.

CONDITIONS: The Government will furnish all cement for use in concrete, mortar, and grout; all reinforcement bars; metergates and vertical gates; the pumping unit; all electrical conduits, conductors, ground wires and boxes; miscellaneous other items. Contractor to furnish all materials required for the completion of the work and to complete work within 175 calendar days. Delays due to action of the Manpower Commission becoming effective subsequent to the date of the bid shall be considered to be delays due to unforeseeable causes, and beyond the control of the contractor. Minimum rate of wages prevailing at the site of work are; $1.37 to $1.50 per hr. for skilled labor; 82¢ to $1.00 for semi-skilled, and 75¢ for common.

BIDS: Five bids were received on September 20, 1945 ranging from the low of $52,582.50 to $66,231.26.

LIST OF BIDDERS:

1. Union Const. Co., Great Falls, Montana $52,583
2. M. G. Long, Billings, Montana 54,594
3. Campbell Const. Co., Malta, Montana 55,046
4. McLaughlin Const. Co., Livingston, Mont. 59,394
5. S. Birch & Sons, Great Falls, Montana 66,231

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Unwatering foundation for pumping station	Lump Sum	$200.00	$2,000.00	$1,800.00
2. Excavation, all classes, for structures	1,200 c. y.	3.00	2.50	2.50
3. Excavation, all classes, for canal	53,000 c. y.	.43	.35	.27
4. Overhaul	2,000 sta. c. y.	.05	.05	.05
5. Backfill	750 c. y.	.50	1.00	1.50
6. Puddling or tamping backfill	350 c. y.	2.00	3.00	2.00
7. Concrete in structures	276 c. y.	40.00	50.00	58.00
8. Placing reinforcement bars	36,000 lb.	.08	.05	.08
9. Dry-rock paving	350 s. y.	5.00	3.00	8.50
10. Furnishing and driving untreated timber piles	630 l. f.	1.75	2.00	3.00
11. Furnishing and driving treated timber piles	160 l. f.	2.00	3.00	3.10
12. Erecting timber in structures	15 M. ft. B.M.	75.00	75.00	100.00
13. Furnishing and installing doors and windows	140 s. f.	1.50	2.00	4.50
14. Furnishing and installing roofing	Lump Sum	175.00	200.00	300.00
15. Installing gates	5,700 lb.	.20	.15	.20
16. Furnishing and installing pump discharge pipe connections	1,250 lb.	.40	.40	.65
17. Laying steel pipe for pump discharge line	320 l. f.	1.00	6.00	5.00
18. Laying 15 in. dia. corr. metal pipe	260 l. f.	.50	1.00	.60
19. Laying 18 in. dia. corr. metal pipe	48 l. f.	.50	1.00	.75
20. Laying 24 in. dia. corr. metal pipe	90 l. f.	.50	1.50	1.00
21. Laying 30 in. dia. corr. metal pipe	284 l. f.	4.00	4.00	1.25
22. Laying 36 in. dia. corr. metal pipe	150 l. f.	3.00	4.00	2.00
23. Furnishing and installing misc. metal-work	2,500 lb.	.40	.40	.60
24. Installing pumping unit	5,500 lb.	.15	.15	.10
25. Furnishing and installing hoist and trolley	Lump Sum	325.00	400.00	275.00
26. Installing electrical metal conduit	220 l. f.	.25	1.00	.50
27. Installing grounding system	150 lb.	.30	1.00	.50
28. Installing electrical conductors and apparatus	1,100 lb.	.20	1.00	.35

AIRPORT, BLOOMINGTON, INDIANA

OWNER: Civil Aeronautics Administration, Chicago, Ill. Mr. I. H. Polk, chief engineer.

PROJECT: The clearing, grading drainage and seeding of the Bloomington, Indiana airport, consisting of the following; 210,000 cu. yd. grading; reinstallation of 445 lin. ft. of 24 in. corrugated iron sewer pipe; seeding of 87 acres; sodding 750 sq. yds.; the addition of 60 tons of straw mulch or hay.

CONDITIONS: Contractor to furnish all materials and to complete work in 75 calendar days. Rail and highway transportation facilities available. The prevailing wage rates are: skilled labor $1.25 to $1.65 per hour; semi-skilled, 75¢ to $1.25 and common 75¢ per hour.

BIDS: Seven bids were received on July 2, 1945, ranging from the contract low of $92,593 to the high of $125,865.

LIST OF BIDDERS:

1. Thompson Const. Co., Indianapolis, Ind. (contract) ..... $ 92,593
2. Ralph Rogers Co., Bloomington, Ind. 93,169
3. Carl Myers Co., Orleans, Ind. 100,579
4. Valley Engr. Co., St. Charles, Ill. 105,028
5. Reith-Riley Const. Co., Goshen, Ind. 110,249
6. Palumbo Exct. Co., Chicago, Ill. 124,163
7. Midland Constructors Inc., Chicago, Ill. 125,865

Item	(Quan.)	Unit Prices (1)	(2)	(3)
1. Clearing and grubbing	60 in. dia.	$2.00	$1.50	$0.80
2. Clearing trees	100 in. dia.	2.00	1.00	.70
3. Removing existing fences	500 rods	2.00	.45	.30
4. Remove concrete inlet	1	50.00	45.00	50.00
5. Remove concrete headwall	1	50.00	45.00	50.00
6. Grading, unclassified	210,000 c. y.	.27	.29	.27
7. Remove 24 in. sewer pipe	460 l. f.	1.50	1.00	2.00
8. Reinstalling 24 in. sewer pipe	445 l. f.	3.00	1.10	2.50
9. Storm sewers, in place 12 in. dia. pipe	250 l. f.	2.25	2.25	1.75
10. 15 in dia. pipe	765 l. f.	2.85	2.35	2.65
11. 18 in. dia. pipe	750 l. f.	3.25	2.80	3.50
12. 21 in. dia. pipe	540 l. f.	3.80	3.15	4.15
13. Storm sewers, in place 12 in. dia. pipe	530 l. f.	2.00	2.05	1.65
14. 14 in. dia. pipe	182 l. f.	2.60	2.20	1.50
15. 18 in. dia. pipe	225 l. f.	3.00	2.55	2.30
16. Manhole, in place	1	225.00	330.00	250.00
17. Inlets and headwalls Concrete	51 c. y.	50.00	74.25	50.00
18. Reinforcing steel	6,000 lb.	.15	.14	.10
19. Grates with frames	25 ea.	45.00	35.00	225.00
20. Raise inlet	1	40.00	44.00	50.00
21. Riprap or concrete	40 s. y.	6.00	11.00	3.75
22. Smoothing areas	5 acre	300.00	50.00	100.00
23. Liming, fertilising and seeding Lime	120 ton	6.00	2.45	3.50
24. Fertilizer	24 ton	72.00	84.00	50.00
25. Seed—30 lbs. per acre	87 acre	45.00	37.00	44.00
26. Seed—60 lbs. per acre	31 acre	55.00	45.50	55.00
27. Cover crop—winter rye	acre	15.00	12.50	30.00
28. Sodding	750 s. y.	.60	.85	.35
29. Hay or straw mulch	60 ton	80.00	100.00	225.00
30. Fencing Class "C"	400 rod	7.00	5.50	4.50
31. Furnish 12 foot gate	2 ea.	30.00	30.00	30.00
32. Furnish and install monuments	10 ea.	25.00	22.00	30.00

FILE THIS UNDER . . .

AIR ENTRAINMENT

For improved plasticity and resistance to freezing and thawing

Darex AEA*

*Reg. U. S. Pat. Off.

What is Darex AEA? Darex AEA is a water-soluble air-entraining agent that comes ready to use for addition at the mixer. With Darex AEA, the amount of air entrained in concrete can be controlled, so that after an initial mixing period the air content of the concrete remains relatively uniform.

Easy to use Darex AEA comes ready to use in solution form. There is no mixing—no harsh chemicals required. The use of measured volumes of Darex AEA gives constant, uniform results.

Economical to use Darex AEA is inexpensive and costs only a few cents per cubic yard of concrete to use.

Is not super-sensitive Small variations in the amount of Darex AEA used are not critical and do not greatly affect the air. This makes for safe use, even with unskilled labor.

Gives improved plasticity Darex AEA works on the sand constituent of concrete as an air-entraining agent and does not react with the alkali in the cement. It gives plasticity and workability, which permit substantial water cuts, make the concrete easy to place, tend to reduce bleeding, and eliminate segregation of the aggregates.

Gives improved durability Darex-AEA-treated concretes containing 3-6% entrained air give remarkable resistance to freezing and thawing.

Proved in use Darex AEA has already been used in over four million cubic yards of concrete. This figure is based on sales to consumers.

Use DAREX AEA with confidence wherever air-entrained concretes are specified.

WRITE FOR BOOKLET AND MANUAL
ON THE USE OF DAREX AEA

IN AIR-ENTRAINED CONCRETES
IT'S THE
Controlled Air
THAT COUNTS

DEWEY AND ALMY CHEMICAL COMPANY
CAMBRIDGE 40, MASSACHUSETTS

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

CONSTRUCTION MATERIAL and labor rates reported in December to *Engineering News-Record* reveal some changes from the preceding month. Cleveland, Minneapolis, Pittsburgh, reflected the OPA ceiling rise in structural clay tile. Wage increases were reported in Baltimore where carpenters now get $1.675 per hr., common labor here has been lifted to 95c. per hr. In Birmingham carpenters are boosted to $1.375 and hoisting engineers to $1.50 per hr. Denver reports $1.625 for carpenters now, with both building and heavy construction common labor up to $1.00 per hr. Montreal also boosted up hoisting engineers to $1.01. Detroit, St. Louis, and Pittsburgh show raises in common and straight brick. In Detroit the rise of common and straight brick to $23.25, includes $2.50 per M. for delivery. St. Louis showed increases in all reported types of wrought steel pipe, as well as an increase in 24-in. concrete sewer pipe. Boston, Dallas and Los Angeles reported no changes in prices or wages.

In Philadelphia, as in most cities, lumber is again classed as a critical material; large quantities of lumber due to military cancellations have not yet been made available. Other materials in tight supply are brick, clay sewer pipe and cast iron soil pipe. The supply of cement is adequate while there are local shortages in concrete blocks.

In Chicago, structural iron workers were granted an hourly rate of $1.88, while journeymen lathers' rate is now $1.99. A raise has also been granted Milwaukee carpenters; is now $1.50 per hr.

CEMENT, AGGREGATE, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT (Per bbl., C/L lots, incl. 40c. per bbl. for bags, cash dis. not deducted)			SAND AND GRAVEL (Per ton, carload lots)			CRUSHED STONE (Per ton, carload lots)		CRUSHED SLAG (Per ton, carload lots, f.o.b. plant)		CONCRETE BLOCK (8x8x16-in.; truckload del.; per block)		CONCRETE Ready Mixed (1:2:4, cuy
	Cloth *a*	Paper	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	Sand-grav.	Lt.wgt. Agg.	50 c.y., de
Atlanta	$2.77	$2.52	$2.47	$1.79	$1.89	$1.99	$1.79	$1.89	$1.59	$1.69	$0.17	....	$8.30
Baltimore	2.62	2.37	2.12	1.80‡	1.80‡	1.30‡	1.80‡	1.80‡	1.75‡	1.75‡	.125	$0.125*w*	7.45
Birmingham	2.50	2.25	2.10	1.75	1.75	1.50	.85	1.00	.90	1.15	.1425	....	5.80
Boston	2.97*b*	2.72*b*	2.52	1.50‡	1.50‡	1.05‡	1.25‡	1.35‡	....	....	.13	.155*w*	7.55*n*
Chicago	2.90	2.65	2.50	2.15‡*d*	2.15‡*d*	2.15‡*d*	2.15‡*d*	2.15‡*d*	1.75‡	1.75‡	.18	.18*x*	....
Cincinnati	2.41	2.16	1.96	1.20	1.20	1.10	1.80	1.80	....	....	.12	.15*w*	6.70
Cleveland	2.59	2.34	2.19	1.75*i*	1.75*i*	1.25/1.65*i*	1.80*i*	1.80*i*	1.15	1.15	.14	.14	7.45
Dallas	2.51	2.26	2.06	1.50*p*	1.70*p*	1.10*p*	1.69*p*	1.79*p*	....	....	.15	....	7.15
Denver	3.32	2.72	2.47	1.20	1.30	1.25	1.65	1.75	1.00	1.00	....	.15	7.25
Detroit	2.59	2.34	2.19	1.50	1.50	1.30	2.25	2.25	2.00‡	2.00‡	.14	.15*w*	7.25
Kansas City	2.58	2.33	2.18	1.85	2.30	1.00	1.91	1.91	....	....	.125	.125*wy*	7.80*n*
Los Angeles	3.20*o*	2.60*o*	....	1.30	1.30	1.15	1.30*f*	1.30*f*	....	....	.04*bb*	.10*aa*	7.25
Minneapolis	3.07	2.82	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	.14	....	7.80
Montreal	....	1.95*r*	1.79*r*	1.65‡*s*	1.65‡*s*	1.50*t*	.80*ct*	.90*ct*	....	....	.17*t*	.17*wt*	7.85*n*
New Orleans	2.41	2.16	1.92	1.67	1.65	1.22	....	....	.90	1.15	.19	....	9.25
New York	2.85‡	2.60‡	....	1.60*de*	1.60*de*	.90*de*	1.70*de*	1.80*de*	....	....	.16	.14*wcc*	8.25
Philadelphia	2.73	2.48	2.28	1.55‡	1.65‡	1.20‡	1.90	1.95	1.10	1.10	.155	.155*w*	8.55
Pittsburgh	2.80	2.55	2.35	1.65‡	1.65‡	1.85‡	2.25‡	2.25‡	1.50	1.50	.17	.17*z*	8.40
St. Louis	3.00	2.72	....	1.75‡	1.75‡	1.25/1.40‡	1.25*h*	1.25*h*	.90*g*	1.10*g*	.155	.135*w*	8.60
San Francisco	2.21	2.01	1.71	1.36	1.36	1.36	1.46	1.46	....	....	....	.21*y*	7.55
Seattle	2.75*o*	3.00*o*	....	2.35d‡	2.35d‡	2.35d‡	2.85‡*od*	2.85‡*od*	....	....	.16	.16*y*	7.25

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* F.o.b. quarry. *d* Per cu. yd. *e* Barge lots alongside docks. *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount of 2 per-cent for cash in 10 days. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days. *r* 10c. per bbl. off, cash 20 days. *s* 8% sales tax included. *t* 8% sales tax not included. *u* Withdrawn. *v* 20c. per bbl. discount; 20c. allowed for returnable cloth bag. *w* Cinder. *x* Waylite. *z* Celocrete. *aa* Pumice. *bb* 4 x 8 x 12 in. *cc* Also 8 x 18 x 18 in.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice. Subject discount 10c. per bbl. 20 days in Montreal.

CURRENT MAXIMUM PRICE BASES AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind	$1.90	$1.85	Ironton, Ohio	$1.80*	$1.75*	Richard City, Tenn	$1.80	$1.7
Dallas, Tex	....	....	Limedale, Ind	....	....	Steelton, Minn	2.00	1.9
Hannibal, Mo	1.90	1.85	Norfolk, Va	....	....	Universal, Pa	1.85	1.8
Hudson, N. Y	....	....	Northampton, Pa	1.75	1.70	Waco, Tex. (Plus 9c. tax in Tex.)	1.75	1.7
Independence, Kans	1.70	1.65	North Birmingham, Ala	....	....	Montreal City (Discount 10c. per bbl. 20 days)	1.68	1.6

*Destination price base; effective Sept., 17, 1945

PAVING BRICK, BLOCK, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICK AND BLOCK			PAVING ASPHALT (Per ton, less than 80 penetration)		ASPHALT BINDERS—FLUXES (Per gal., 80–300 penetration)		CUTBACK ASPHALT (Per ton)		ROAD OIL (Per gal.)	ASPHALT EMULSION (Quick-breaking) (Per gal.)	
	Granite per M lots of 50,000 4x4x8 in.	Brick per M 3x4x8½ in carload lots	Wood per sq. 6d. 3½ in 16-lb. treat	Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$73.00	$39.35	$2.25	$18.53*e*	.....†	$0.0740*e*	.....†	$0.0806*he*	.....†	$0.0781*e*	$0.0806	.....†
Baltimore	150.00‡	49.00	85.00*m*	15.00*r*	21.00*r*	.06*r*	.09*r*	13.00*r*	23.00*r*	.06*r*	.07*r*	.14*r*
Birmingham	150.00	32.00*j*	.....	17.95	.....†	.0747	.....†	.0834*h*	.....†	.065	.095	.....†
Boston	85.00	59.00	3.75	15.00	24.00	.0625	.115	17.00	30.00	.0625	.0825	.145
Chicago	150.00	55.00	2.50/2.80*d*	14.00	22.50	13.00*g*	21.50*g*	.0575*h*	.15*h*	.05*n*	.09/.10*n*	.13/.15*n*
Cincinnati	120.00	55.75	.....	17.00	.....	.085	.....	12.25	.....	.07	.085	.....
Cleveland	120.00	34.00	3.59	17.00	19.00	.085	.095	.10*h*	.11	.08	.10	.....
Dallas	.....	36.00	.....	13.65	20.30	.06	.11	16.00	24.80	.06	.05/.07	.07/.09
Denver	.....	16.11	.....	11.00	.....	10.00	.....	.045*h*	.....	.....	.....	.....
Detroit	.....	37.00	.....	18.06*f*	25.60*f*	.0734	.128	.0718*h*	.119*h*	.067	.0775	.1140
Kansas City	.....	44.00	.....	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	.....	50.00	.....	9.00*b*	23.00	9.50*bg*	24.00*bg*	9.50*b*	.....	.025	.072	.15
Minneapolis	.....	.....	2.017*d*	.....	27.70	.....	.128	.....	32.64	.....	.....	.....
Montreal	70.00	.....	.....	16.60*k*	24.25*k*	.116*k*	.1485*k*	.115*hk*	.135*hk*	.08*k*	.135*k*	.188*k*
New Orleans	.....	.....	.....	13.50*a*	20.00*a*	.057	.088	.06*h*	.095*h*	.....	.080	.....
New York	.....	65.00	.....	17.40	24.20*p*	14.00	.....	.0725*h*	.1325*hp*	.....	.0725*p*	.119*p*
Philadelphia	150.00	62.00	4.06	15.00*r*	.....	14.00/15.00	.....	.0625*h*	.....	.....	14.00*gr*	.....
Pittsburgh	135.00	39.75	.....	18.00	23.00	.09	.16	20.00	36.00	.07	.06	.11
St. Louis	.....	39.00	.....	16.00	22.00	15.00*g*	21.00*g*	.0575*h*	.12125*h*	.048	.06	.11
San Francisco	.....	45.00	.....	10.90	21.15	10.90*g*	18.00*gr*	12.90	17.50*r*	9.50*gr*	.0525	.1125
Seattle	.....	.....	.....	10.90*s*	21.90*s*	.....	20.40*gs*	11.40*s*	.....	10.90	.0525*s*	.0625*s*

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse *c* 3½ x 4 x 8½ in. *d* 2-in. interior block, 6-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. Mexican. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3 x 3½ x 8½ in. *k* Tax included. *l* F.o.b. Toledo. *m* Per thousand. † Available on priority only and quoted specially. *p* No steel drum shipments except to armed forces. *r* February 1943 prices, none later available.

Greater bruise resistance built into this new kind of tire

RECORDS show that a new B. F. Goodrich construction principle greatly benefits users of off-the-road tires. For example, a war emergency earth-moving contract required 42 trucks. Trucks had an 11-mile loaded haul down a slight grade at 30 m.p.h. Load — 16 yards, averaging 3000 lbs. per yard. Gross axle loads were: empty—front, 9000 lbs.; drive, 12,000; rear, 10,000; full—front, 11,000; drive, 36,000; rear, 38,000.

On this urgent job, tires had to be subjected to unusual, continuous overload — a practice not recommended. But, the contractor-engineer's report on comparative service of the three brands of 21.00/24 off-the-road tires used, during a 20-day working period, reveals the following: Of 70 brand "A" tires, 24 were removed due to failures; of 46 brand "B", 7 failed; of 38 B. F. Goodrich, *none* failed.

One reason why B. F. Goodrich off-the-road tires stand up so well is that their built-in *shock shield* protects them against the pile driver blows of hitting rocks, ruts, and other unavoidable damaging obstructions. This shield is a special tire construction principle that greatly reduces shocks and impacts that cause bruises and blow-outs. It's a B. F. Goodrich development—exclusive with B. F. Goodrich off-the-road tires.

Users of these off-the-road tires report fewer bruises, far less ply separation, longer wear. You can gain the same savings. Your own comparison tests of B. F. Goodrich tires alongside other makes will prove it to you.

Supplies of some sizes are available for immediate delivery; stocks of certain other sizes are still limited. See the B. F. Goodrich dealer, or write us direct. *The B. F. Goodrich Company, Akron, Ohio.*

Truck Tires BY

B.F. Goodrich

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¼-in. billet *b*	RIVETS ½-in structural	WIRE NAILS Base *d*	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle Bars	Std Spikes *c*	Tie Plates *c*	Track Bolts
Birmingham	$2.10	$2.15	$3.75	$2.90	.....	$43.00	$45.00	$45.00*	$2.70	$3.25	$2.30	$4.75
Chicago	2.10	2.15	3.75	2.90	$2.40	43.00	45.00	45.00*	2.70	3.25	2.30	4.75
Pittsburgh	2.10	2.15	3.75	2.90	2.40	43.00	45.00	45.00*	2.70	3.25	2.30	4.75
Buffalo	2.10	2.15	.....	.....	2.40	.....	.....	.....	....	....	2.30	....
Cleveland	2.10	2.15	3.75	2.90	.....	.....	.....	.....	....	....	....	....
Youngstown	....	2.15	.....	.....	.....	.....	.....	.....	....	3.25	....	....
Detroit	....	2.27‡	.....	.....	.....	.....	.....	.....	....	....	....	....
Gulf ports	2.47*a*	2.52*a*	.....	.....	2.85*a*	.....	.....	.....	....	....	....	....
Pacific ports	2.75*a*	2.80*a*	.....	3.40	2.95*a*	.....	.....	.....	....	....	....	....

‡ Delivered. *a* F.o.b. cars dock. *b* Rail steel same as billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per cl. * Per net ton.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LBS., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb base price	REINFORCING BARS* Per 100 lb., ¾ in., base price 15 tons or over *b* New billet	Rail steel	Add Switch	$/cwt. for Del.	EXPANDED METAL LATH Per 100 sq. yd., carload lots Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING Per 100 sq. ft., carload lots 4x16 in., No 5 & 10 wires	4x12 in., No 8 & 12 wires	6x6 in. No 6 & 6 wires *k* Per 100 s. f.	SHEET PILING Per 100 lb. base price
Atlanta	$2.34	$2.40	$2.40	$.02½	$.10	$21.06	$23.00	$1.82	$1.35	$1.91	$3.04
Baltimore	3.70	2.90	2.75	....	.10	23.00	25.00	1.70	1.27	1.79	3.00
Birmingham	2.10*a*	2.15	2.15	.02½	.10	19.00	21.00	1.80	1.34	1.89	....
Boston	3.912	3.994	....	$20 C.L.	.10	18.50	29.50	1.76	1.31	1.84	2.77
Chicago	2.10*a*	2.15*a*	2.15*a*	.03	.05	21.50	23.50	1.67	1.25	1.75	2.40
Cincinnati	3.68	2.53*ed*	2.53*ed*	....	.05	19.50	21.50	1.66	1.25	1.74	....
Cleveland	3.588*k*	3.10*k*	3.10*k*	.02½	.10	20.50	22.50	1.66	1.25	1.74	....
Dallas	4.25	3.17	3.17	....	....	25.50	27.50	1.93	1.42	2.03	....
Denver	4.57	4.09	....	....	....	26.50	26.50	1.97	1.45	2.07	....
Detroit	3.661‡	2.50‡	2.50‡	....	.10	30.00	30.00	1.68	1.26	1.76	2.66
Kansas City	4.19	2.61*ed*	2.61*ed*	.0	.05	24.50	26.50	1.78	1.33	1.87	2.874
Los Angeles	3.65*f*	2.575	2.425	.02½	.05	23.00	27.50	1.93	1.42	2.03	3.65
Minneapolis	3.81‡	2.73	2.73	.0	.10	21.00	23.00	1.80	1.34	1.89	2.73*d*
Montreal	3.95*i*	2.90*i*	2.80*i*	....	....	31.00*hi*	46.00*hi*	2.76*i*	3.44*i*	2.82*im*	....
New Orleans	4.158‡*k*	3.59*k*	....	.05	.10	23.50	22.00	1.82	1.35	1.91	2.875
New York	3.75	2.76*c*	2.76*c*	....	.15	17.50	19.50	1.76	1.32	1.81	2.74
Philadelphia	3.666	3.668	....	....	....	20.50	22.50	1.71	1.28	1.79	2.72
Pittsburgh	2.10*a*	2.15*a*	2.15*a*	.02½	.10	23.00	26.50	1.59	1.20	1.67	2.40
St. Louis	3.697	2.74	2.74	.0	.05	28.00	34.00	1.69	1.27	1.78	2.70
San Francisco	4.35	2.825	2.675	.02½	.10	21.00	24.50	1.93	1.42	2.03	3.70
Seattle	2.75*e*	2.80*e*	....	....	....	34.50	38.50	1.93	1.42	2.03	2.95*e*

‡ Delivered. *a* Mill prices. *b* 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 25c.; 1 to 5 tons, add 10c. * High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills. *h* List price. *i* Plus Dominion and Province sales tax. *k* Quotation on changed basis; no actual price change. *m* Per sq. yd.

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in.*a*	VITRIFIED SEWER PIPE Per foot, std. 8 in., s.s.	Delivered std. 12 in., s.s	ASTM 24 in.	C13–35 36 in	CLAY DRAIN TILE Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	CONCRETE SEWER PIPE Per ft., delivered; ASTM 12 in.	C 14–35 24 in.	WROUGHT STEEL PIPE Full standard weight, *h* 1 to 3 in., Butt Weld Black %	Galv. %	3½ to 6 in.; Lap Weld Black %	Galv. %
Atlanta	$50.66	$0.31*b*	$0.558*bc*	$3.082*e*	$5.70*e*	$110.00	$140.00	$0.45	$1.70	48.2	54.2	59.7	51.2
Baltimore	54.00	.35	.60	2.70	7.25	160.00	200.00	.65	1.90	65.5	57.5	63.0	54.5
Birmingham	46.00	.275	.495	1.95	5.50	100.00	220.00	.50	1.70	62.2	54.2	59.7	51.2
Boston	56.40	.371*r*	.7155*r*	2.79*r*	7.6875*r*	170.00‡*r*	265.00‡*r*	.60	1.95	....	....	....	....
Chicago	55.33	.35	.675	2.70	7.00	100.00‡	150.00‡	.45	1.85	66.0	55.0	64.5	53.0
Cincinnati	54.27	.231	.4455	1.80	5.125	105.00‡*s*	170.00‡*s*	.75*t*	1.75*t*	57.1	43.4	54.0	39.6
Cleveland	55.75	.266*r*	.513	2.15	5.535	90.60	139.40	.36	1.40	68.5	57.5	66.0	54.5
Dallas	57.43	.31	.58	2.25	5.00	90.00	110.00	.46	1.57	....	....	....	....
Denver	62.56	.32‡	.576‡	2.376‡	.....	143.00‡	264.00†	1.00†	2.05†	58.4	50.4	55.7	47.2
Detroit	55.75	.385	.7425	2.925	7.75	170.00‡*u*	263.00‡*u*	.36	1.75	57.6	44.0	54.5	40.2
Kansas City	56.73	.31	.56	2.20	6.20	154.00	286.00	.45	1.60	35.6	46.1	46.2	59.4
Los Angeles	69.40	.325†	.585†	2.70†	6.75†	130.50	217.50	1.00	2.00	61.1	50.1	58.6	47.1
Minneapolis	58.83	.305†	.549†	2.196†	6.25†	.....	.....	.90	2.10	64.2	53.2	60.7	49.2
Montreal	67.00	.85*e*	1.50*e*	5.25*p*	8.50*ep*	45.00*m*	64.00*m*	.811*m*	2.31*m*	....	....	....	....
New Orleans	52.78	.37*r*	.78	1.69	.....	150.00	220.00	.45	1.65	62.4	54.4	58.8	50.3
New York	53.40	.35	.675	2.835	7.35	.....	.....	.60	1.40	64.9	53.9	62.4	50.9
Philadelphia	52.00	.35	.675	2.835	7.35	165.00	225.00	.45	1.75	56.6	42.8	53.6	39.1
Pittsburgh	57.00	.266†	.513†	2.295†	5.945	97.80	154.20	.85*g*	2.00*g*	68.5*i*	57.5*i*	66.0*i*	54.5*i*
St. Louis	53.84	.31	.558	2.232	4.95	93.50	242.00	1.00*j*	2.15*k*	68.5	57.5	66.0	54.5
San Francisco	69.40	.3625*d*	.6525*d*	2.61	6.52	115.00	192.50	.58	2.34	45.0	31.0	41.0	26.0
Seattle	71.20	.40	.72	2.88	....	115.20	.....	.51*f*	1.44*f*	....	....	....	....

‡ Delivered. †F.o.b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $50.00. Based on existing freight rates; subject to rate change. Gas pipe and class A. $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.; ¾ in., 8½c.; 1 in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92; 3 per cent tax on transportation costs not included. *i* Applies also at Lorain, Ohio mills. Chicago delivered base is 2½ points less on butt, 1½ on lap. Freight is figured from Pittsburgh. Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base. Butt-weld—1 in. and 1¼ in. black 34 galv. 16; 1½ in. black 38 galv. 18½ 2 in. black 37½, galv. 18. Lapweld—2½ in. to 3½ in. black 31½ gal. 14½; 4½ in.; to 8 in black, 32½ galv. 17. Reinforced; spec. C 76–37. *k* Reinforced; spec. C 75–37. *l* Plus sales tax. *m* Centri. spun. *n* 27-in. pipe. *o* Less 50%. *p* Less 53%. *s* Price quotations on delivered basis since Mar. 1940; current f.o.b. price $84 for 6 in.; $130 for 8 in. *t* Reinforced pipe prices since May, 1937; current plain pipe prices are: 12 in., 36c.; 24 in. $1.50. *u* Scarce: carload quantities not readily available.

LUMBER, TIMBER PLYWOOD—PER M FT., B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face)									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD Rail freight increment (See note for base price)	
	All Fir planks No. 2 common, Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)												
	1x6 S1S	1x8 S1S	2x4 S4S	2x6 S4S	2x8 S4S	2x10 S4S	3x12 Rgh	6x12 Rgh	12x12 Rgh	2x12 Rgh	12x12 Rgh	5/8"	3/4"
Atlanta	**$41.00**	**$41.00**	**$35.50**	**$38.50**	**$37.50**	**$41.50**	**$45.00**	.....	.....	$60.50	$64.00	$17.90	$21.85
Baltimore	**44.00**	**46.00**	**44.00**	**46.00**	**47.00**	**52.00**	**65.00**	.....	.....	115.00	120.00	18.25	22.25
	48.00	*49.00*	*55.00*	*55.00*	*55.00*	*57.50*	*68.00*	*$75.00*	*$75.00*	.....	.....	.....	.....
Birmingham	**45.00**	**45.00**	**44.50**	**43.50**	**44.50**	**47.50**	**68.00**	**55.00**	**56.00**	.....	.....	17.35	21.15
[1]	50.00	50.00	49.50	48.50	49.50	52.50	72.00	.....	.....	67.50	70.00	.....	.....
Boston	**60.00**[3]	**60.00**[3]	**60.00**[3]	**60.00**[3]	**60.00**[3]	**62.00**[3]	**66.00**[3]	.....	.....	58.00[3]	58.00	18.25	22.25
	55.00	*55.00*	*54.00*	*54.00*	*54.00*	*54.00*	*68.00*	*68.00*	*68.00*	.....	.....	.....	.....
Chicago	**55.00**	**55.00**	**58.50**	**54.00**	**54.00**	**60.00**	**68.00**	.....	.....	80.00[l]	95.00[l]	14.60	17.80
	55.00	*55.00*	*54.00*	*54.00*	*54.00*	*55.00*	*56.00*	*56.00*	*57.00*	.....	.....	.....	.....
Cincinnati	**47.50**	**49.00**	**42.50**	**42.50**	**42.50**	**44.50**	**67.00**	.....	.....	65.00	65.00	17.35	21.15
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cleveland	**42.50**[k]	**42.50**[k]	**52.50**[k]	**51.00**[k]	**65.00**	**65.00**	**83.00**	**83.00**	**83.00**	.....	.....	17.75	21.60
Dallas	**45.25**	**45.25**	**44.50**	**43.00**	**43.00**	**47.25**	**60.75**	**58.75**	**58.75**	88.75	85.00	14.60	17.80
Denver	**64.25**[4]	**64.25**[4]	**64.75**[4]	**65.25**[4]	**63.75**[4]	**64.75**[4]	**68.75**[4]	*72.00*	*72.25*	.....	.....	10.45	12.70
Detroit	**61.00**	**61.00**	**57.75**	**57.75**	**57.75**	**63.75**	**71.00**	.....	.....	70.75	90.00	17.35	21.15
	57.00	*57.00*	*57.00*	*57.00*	*62.75*	*72.75*	*75.00*	*75.00*	*90.00*	.....	.....	.....	.....
Kansas City	**69.00**	**69.00**	**67.00**	**65.50**	**67.00**	**69.00**	**84.00**	.....	.....	84.00	94.00	12.60	15.40
	66.00	*66.00*	*59.50*	*59.50*	*59.50*	*59.50*	*75.00*	*80.00*	*80.00*	.....	.....	.....	.....
Los Angeles	*60.00*	*60.00*	*60.50*	*60.75*	*59.25*	*59.25*	*72.75*	*72.00*	*72.00*	.....	.....	9.90[g,h]	12.05[g,h]
Minneapolis	**63.00**[4]	**62.00**[4]	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.60	15.40
[‡]	*69.00*	*69.00*	*60.00*	*61.00*	*59.00*	*60.00*	*61.00*	*65.00*	*65.00*	.....	.....	.....	.....
Montreal	[†7] *64.00*	*65.00*	*60.00*	*63.00*	*65.00*	*70.00*	.....	.....	.....	200.00	200.00	.....	.....
	90.00	*90.00*	*90.00*	*90.00*	*90.00*	*90.00*	*80.00*	*80.00*	*80.00*	.....	.....	.....	.....
New Orleans	**41.00**	**39.50**	**37.00**	**35.00**	**34.00**	**36.00**	**46.00**	.....	.....	55.00	69.00	14.60	17.80
	30.50	*30.50*	*30.00*	*30.00*	*29.00*	*29.00*	*28.50*	*29.50*	*29.50*	.....	.....	.....	.....
New York	**67.50**	**67.50**	**62.50**	**62.50**	**62.50**	**64.00**	**74.00**	.....	.....	120.00[f]	125.00[f]	18.35	22.25
[‡]	.....	.....	*66.00i*	*65.00i*	*65.00i*	*65.00i*	[Range from $75 to $95]			.....	.....	.....	.....
Philadelphia	**75.00**	**75.00**	**75.00**	**75.00**	**75.00**	**75.00**	**75.00**	.....	.....	130.00	130.00	18.25	22.25
	75.00	*75.00*	*75.00*	*75.00*	*75.00*	*75.00*	*85.00*	*90.00*	*90.00*	.....	.....	.....	.....
Pittsburgh	**50.80**	**53.20**	**62.75**	**55.00**	**60.85**	**62.50**	**76.25**	.....	.....	.....	.....	18.10	22.05
	69.20	*68.10*	*66.10*	*65.30*	*65.20*	*65.65*	*82.75*	*88.75*	*88.75*	.....	.....	.....	.....
St. Louis	[‡c] **61.00**	**61.00**	**57.00**	**56.00**	**57.00**	**59.00**	**71.00**	*75.00*	*75.00*	87.00	87.00	14.60	17.80
San Francisco	*d* *41.00*	*41.00*	*36.50*	*36.75*	*35.75*	*35.75*	*37.50*	*56.00*	*56.00*	.....	.....	7.30[g]	8.90[g]
Seattle	*45.50*	*45.50*	*45.75*	*45.75*	*44.50*	*44.50*	*47.75*	*47.75*	*46.50*	.....	.....	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers N. C. Pine. [3] Spruce. [4] Native. [5] Western Pine, No. 3 Common. [6] Spruce. [7] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* F.o.b. cars San Francisco freight rate. *e* 10% discount taken off. *f* Up to 18 ft. † Plus sales tax.

Note: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on 5/8", $95.15; on 3/4", $104.85; price includes oiling and sealing charges. For other centers add rail freight increment from table or proper size. For resin dipped treatment, add $10.50 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum. *i* Ranges from $65 to $75. *j* Average price. *k* August 1943 price. *l* September price; none later available.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS — Discounts from jobbers list, Aug. 15, 1938 Single or Double Thickness A quality	B quality	EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*
Atlanta	74%	75%	$0.15
Baltimore	78%	79%	.15
Birmingham	76%	76%	.105
Boston	77%	78%	.15
Chicago	77%	77%	.15
Cincinnati	77–10%	77–10%	.15
Cleveland	77%	77%	.19
Dallas	76%	76%	.1625
Denver	76%	76%	.155*e*
Detroit	77%	77%	.1575
Kansas City	77–10%	77–10%	.155
Los Angeles	86%*d*	88%*d*	.1575
Minneapolis	77%	77%	.155
Montreal	40–10–2%*ab*	50–2%*ac*	.1675†
New Orleans	70%	75%	.16
New York	81%	82%	.22*f*
Philadelphia	78%	79%	.15
Pittsburgh	79%	79%	.1225
St. Louis	77–10%	77–10%	.155
San Francisco	66%	73%	.155
Seattle	75%	75%	.1575†

Price of 60% Ammonia Gelatin in $0.01 per lb higher than 40%

a Discount from list Sept. 1939; sales tax included, but 6% tax exemption not allowed for. *b* Single thickness. *c* Double thickness. *d* Discount from jobbers' list Sept. 15, 1928.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal St. add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla. and Me. — $0.105	$0.13	$0.15
W. of Miss. to Rocky Mtn. States, Fla. and Maine. — .11 –.1175	.135 –.1475	.155 –.1675
Rocky Mtn. States — .11 –.1225	.135 –.1525‡	.155 –.1725‡
Pacific N. W. States — .1075–.12	.1375–.15	.1575–.17
Pacific S. W. States — .1050–.1125	.135 –.1425	.155 –.1625

‡ F.o.b. Louviers, Colo., or Butte, Mont.

PILES TIES— F.O.B.

PILES

Prices per linear foot, fir and pine, bark on, f.o.b. cars, New York. Fir based on Wash. and Ore. points to New York shipping area; pine based on freight from Norfolk.

Dimensions	Points	Length	By Rail — Pine*	Fir
12-in. at butt	6-in	30 to 50-ft.	$0.34	.....
12 in.— 2 ft. from butt	6-in.	50 to 59-ft.	.35	.....
12-in.— 2 ft. from butt	6-in.	60 to 69-ft.	.36	.....
12-in.— 2 ft. from butt	6-in.	90 to 100-ft.	....	.5325
13-in.— 3-ft. from butt	5-in.	91 to 100-ft.	....	.5725
14-in.— 2-ft. from butt	6-in.	50 to 69-ft.	.41	.6275
14-in.— 2-ft. from butt	6-in.	70 to 79-ft.	.43	.67
14-in.— 2-ft. from butt	5-in.	80 to 85-ft.	.54	.....
14-in.— 2-ft. from butt	5-in.	85 to 89-ft.	.57	.....
14-in.— 2-ft. from butt	5-in.	90 to 100-ft	....	.62

* Pine piling over 80-ft. available only in limited quantities.

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6"x8"x8' Untr.	6"x8"x8' Tr.	7"x9"x8'6" Untr.	7"x9"x8'6" Tr.
Boston	Oak	$1.50	....	$2.00	....
	Pine	2.00	$3.00*a*	2.50	$3.00*a*
New York	S. L. Sap Pine	1.43/1.54	2.59	1.76	2.86
	Mixed Oak	1.71	2.59	2.42	3.58
Birmingham	White Oak	1.00	1.60*a*	....	2.25*a*
Chicago	Red Oak	....	2.45/2.65*a*	....	3.35/3.60
Los Angeles	Douglas Fir	2.00	3.25*a*	2.90	4.70*a*
Philadelphia	Red Oak	....	2.10*ag*	....	3.25*ag*
St. Louis	White Oak	1.60	....	2.19	....
	Red Oak	1.63	2.15*a*	2.19	3.25*a*
	Sap Pine or Cypress	1.70	....	2.06	....
San Francisco	Douglas Fir	1.25*bef*	....	....	3.00*caf*
Montreal	Birch or Maple	....	1.65	1.04	....

Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6"x8"x8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* F.o.b. cars. † Out of market. *g* January 1943 price, none later available.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb	$2.50– 3.10
Chlorine cylinders, liquid, per lb., delivered	.0525
Calcium chloride, 77–80%, flaked, 100-lb. paper bag, del'd, ton.	18.50–35.00
Silicate of soda, 52 deg. in drums, f.o.b. works, per 100 lb	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.15
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00–25.00
Sulphate of copper, in bbl., per 100-lb	5.00

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE PARTITION — SCORED Per M lots of 2,000 pieces or over, 3x12x12 in.	4x12x12 in.	8x12x12 in.	STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M lots of 2,000 pieces or over, 8x12x12 in.	10x12x12 in.	12x12x12 in.	BRICK Per M in quantity Common backing	Straight hard	LIME Per ton, Hydrated finishing	In paper, Common hydrated	Carload lot, Pulverized, or lump
Atlanta	$104.00	$114.00	$199.00	$234.00	$244.00	$250.00	$18.25	$20.04	$26.54	$15.04	$15.04
Baltimore	84.00	90.00	170.00	200.00	260.00	300.00	17.00*k*	21.00*k*	19.00	14.00	2.50*m*
Birmingham	80.00	85.00	160.00	191.00	252.00	288.00	16.50	23.00	18.11	13.64	2.25*o*
Boston	103.75*a*	110.65*a*	207.45*a*	248.90	.....	.....	20.00*i*	20.00*i*	21.00†	.....	16.00
Chicago	85.80	91.70	172.60	.....*x*	.....*x*	.....*x*	17.00	18.00	17.00	15.00	12.50
Cincinnati	65.55	69.90	131.20	148.70	210.35	240.45	27.75	27.75	15.50	13.00	.....
Cleveland	97.50	104.00	.....*x*	.....	.....	.....	22.75	22.75	15.75	13.25	.....
Dallas	71.40	76.40	145.30	183.50	238.00	294.50	15.25*i*	16.75*i*	19.00	15.00	15.00
Denver	99.00	112.00	185.00	214.00	248.00	294.00	21.50	18.00	25.00*j*	17.00*j*	20.00*j*
Detroit	92.70	96.70	174.50	198.80	257.20	294.30	23.25	23.25	18.00	16.00	16.00
Kansas City	67.00	69.00	89.00*c*	128.00	163.00	189.00	17.50	18.50	19.32	13.00	10.92
Los Angeles	73.50†*r*	89.50†*r*	128.00*c*†*r*	210.00†*r*	368.00†*r*	460.00†*r*	13.50	15.00	16.50	17.50	17.50
Minneapolis	111.60*b*	111.60*b*	186.25*b*	.....	189.00*b*	262.00*b*	25.50	31.50*g*	21.00	16.00	19.00
Montreal	92.50*a*	98.50*a*	196.25*a*	151.50*a*	100.50*at*	134.50*au*	22.16†*u*	33.20†*u*	24.60*u*	15.00*u*	14.00*u*
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	99.40	106.00	145.75*e*	235.00*h*	287.40*h*	355.80*h*	19.50/20.50	.....	20.00	14.00	17.00
Philadelphia	112.10	119.60	224.20	269.10	321.20	405.10	20.75	23.75	19.00	16.00	15.00
Pittsburgh	87.20	91.20	169.80	252.00	284.00	325.00	23.25	25.25	17.90	15.40	2.55*m*
St. Louis	67.00	72.00	130.00	190.00	244.00	290.00†	22.50	21.50	22.00	18.00	2.50*m*
San Francisco	96.00	108.00	144.00	108.00*t*	.....	.. ...	22.50	.....	24.00	23.00	2.50*m*
Seattle	115.00	125.00	230.00	.....	.....	.....	20.50*f*	24.00*f*	20.00*s*	20.00*s*	3.00*m*

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6x12x12 in., 3-cell. *d* Not load bearing. *e* 48 lb. tile. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* F.o.b. Warehouse only. *f* LCL. *h* $1.00 discount if paid in 10 days. *i* Lump. *m* Per bbl., 180 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *r* 5% discount 10 days *s* 2% discount for cash. *t* 5½x8x12. *u* 8% sales tax included. *v* 6x12x12-in. *w* Per 200 lb. bag. *x* Not available.

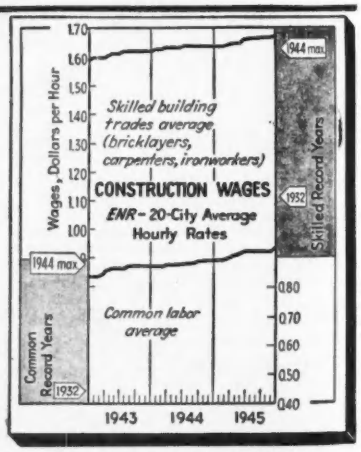
PAINT, ROOFING—F.O.B. CARLOAD LOTS

	RED LEAD Per 100 lb. in 600-lb. (Approx.) bbl Dry *a*	WHITE LEAD Per 100 lb. in oil	READY-MIXED PAINT Per gal., drums Graphite *b*	Aluminum *b*	ROOFING SUPPLIES Ferric Oxide *d*	Rolls, slate surfaced, 85–90 lb. per sq.	Asphalt felt, per 100 lb.	Carload lots f.o.b. factory— Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$10.25	$14.125	$1.30	$2.25	$1.20	$1.85	$1.72	$1.72	$0.305	$27.00
Baltimore	10.00	13.75	2.00	3.00	2.50	2.30	2.70	2.70	.40	29.00
Birmingham	10.25	14.125	2.35	3.50*r*	1.98*r*	2.09	1.98	1.98	.32	28.35
Boston	10.00	13.75	1.75	2.50	2.31	2.00‡*h*	3.30‡*u*v	3.30‡*u*v	.25‡	21.00‡
Chicago	10.00	13.75	....	....	....	1.75*hf*	1.74*hf*	1.82*hf*	.33*f*	23.00*f*
Cincinnati	10.00	13.75	1.70	2.90	1.60	2.20	2.10*h*	2.10*h*	.33	25.00
Cleveland	10.00	13.75	1.70	2.90	1.60	1.71	1.63*h*	1.61*h*	.237	25.00
Dallas	10.00	14.50	1.88	2.11*n*	.05*l*	1.75*h*	1.66*h*	1.66*h*	.35	39.00
Denver	10.00	14.25	....	....	.27*l*	2.45	2.95	2.95	.35	28.00
Detroit	10.00	13.75	1.75	3.00	1.60	2.25	2.25	2.25	.50	23.00
Kansas City	10.00	13.875	2.30*g*	2.55*gr*	2.16*g*	2.19	2.30	2.30	.28	27.50
Los Angeles	10.25	14.25	1.60	2.25	2.30	2.10	1.50	....	.45	.....
Minneapolis	10.00	13.875	....	....	....	1.7123*i*	1.6243*hi*	1.6243*hi*	.32	23.00
Montreal	.....	11.05	2.50*p*	4.90*p*	3.15*p*	4.02*t*	2.58*t*	3.01*t*	.38*t*	2.10*kl*
New York	10.00	13.75	2.03	....*r*	1.82	1.7098	1.6273*a*	1.6273*o*	.26	23.00
Philadelphia	10.00	13.75	1.60/1.80	2.20*r*	1.55	2.25	2.71	2.71	.32	23.00
Pittsburgh	10.00	13.75	1.05	1.95	.80	1.95	1.84*h*	1.84*h*	.34	26.00
St. Louis	10.00	13.75	2.28*s*	2.89*s*	1.96*s*	1.77	1.77	1.77	.35	23.00
San Francisco	10.25	14.00	1.80	2.75*n*	1.35	1.71	2.40	2.40	.33	20.50
Seattle	10.25	14.25	1.90	3.00	....	2.15	2.16*h*	....	.35	26.50*j*

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3–49A. *c* ASTM Spec. D266–31. *d* 80% minimum ferric oxide. *s* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. can. *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* Per 100 lb. *l* Per lb. *m* Per bbl. *n* May, 1941 price. *o* 60-lb. roll. *p* Plus 8% sales tax. *r* Not available, except on priority rating; then quoted specially. *s* December, 1942 price. *t* Federal tax included. *u* 90-lb. roll. *v* Truck delivery.

SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.50	$1.25	$1.50	$1.25	$1.50	$0.40	$0.50
Baltimore	1.75	1.675	1.80	1.625/1.80	1.725	.95	.95
Birmingham	1.75	1.375	1.625	1.50	1.65	.65	.65
Boston	1.625	1.50	1.675	1.50/1.875	1.667	1.00	1.00
Chicago	1.90	1.85	1.88	1.85	1.90	1.20	1.20
Cincinnati	1.825	1.60	1.725	1.45/1.60	1.75	.90	.90
Cleveland	1.875*c*	1.65	1.875	1.875	1.875	1.085	1.125/1.155
Dallas	1.625	1.25	1.50	1.75	1.625	.60	.75/1.25
Denver	1.80*b*	1.625	1.50*b*	1.50/1.625*b*	1.55	1.00	1.00
Detroit	1.725	1.50	1.825	1.675/1.825	1.775	1.00	1.00
Kansas City	1.75	1.575	1.70	1.70	1.75	.975	.90
Los Angeles	1.50	1.35	1.625	1.375	1.667	.875	.875
Minneapolis	1.625	1.50	1.625	1.60	1.725	.95	.95
New Orleans	1.625	1.375	1.625	1.55	1.50	.70	.80
New York	2.00*b*	1.85*b*	2.00	2.00*b*	2.00*b*	1.10	1.10
Philadelphia	2.00	1.58	1.90/2.00	2.25	2.00	.90	.90
Pittsburgh	1.90	1.75	1.75	1.8125	1.875	1.00	.90
St. Louis	1.90	1.70	1.90	2.00	1.75	1.00	1.00
San Francisco	1.875	1.50	1.75	1.50/1.75	1.75	1.00	1.00
Seattle	1.845	1.545	1.745	2.00	1.845	1.145	1.145
Montreal*	1.06	.96	1.01	1.01	1.06	.61	.66



ENR Skilled Average; (Bricklayers, Carpenters, Ironworkers) $1.682.
ENR Common Average; $0.938.

b 7 hr. day. *c* Prevailing rate on government work.
* Cost of living bonus now included in basic wage.

10 BIG REASONS WHY...

OWNERS PREFER ADAMS MOTOR GRADERS

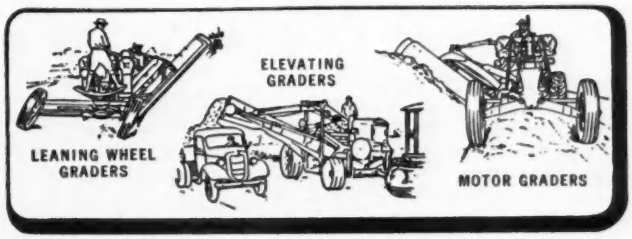
★ There are many reasons why Adams Motor Graders are the outstanding choice of owners who demand the utmost in performance, utility, endurance and economy. Here are ten of the foremost:

1. **STRENGTH AND DURABILITY**—Adams have the rugged strength and stamina to stand up under continuous hard work—with minimum maintenance and repair.
2. **BALANCED DESIGN**—Weight is distributed to exert adequate blade and scarifier pressures, utilizing full power and traction of Adams machines.
3. **POWER AND TRACTION**—All models powered by dependable International engines, with lugging ability to hang on in tough going. Suitable traction utilizes full engine power.
4. **ADAPTABILITY TO WIDE RANGE OF JOBS**—All models, from smallest to largest, are adaptable to every type of surface, ditch and bank work of which motor graders are capable.
5. **WIDE RANGE OF SPEEDS**—All models have wide range of working speeds, plus high top speeds for fast transport from job to job.
6. **EASY STARTING**—Push-button starting available—engine starts easily, in any weather.
7. **DEPENDABLE OPERATING CONTROLS**—Adams positive mechanical controls always operate at uniform speed, regardless of number used at any one time.
8. **ECONOMICAL OPERATION**—International engines are easy on fuel and oil—economical to keep up. All working parts of graders are adjustable for wear, insuring long life.
9. **BIG FRONT AXLE CLEARANCE**—Adams high-arch front axle provides exceptional clearance—no power wasted bulldozing axle through heavy windrows.
10. **WORLD WIDE DEALER SERVICE**—Adams machines are sold and serviced throughout the United States and Canada, and in 30 countries all over the world.

The proof of Adams superiority is in the performance facts. Ask your near-by Adams dealer for the full, convincing story.

J. D. ADAMS MANUFACTURING CO.
Indianapolis, Indiana

Adams
ROAD-BUILDING AND EARTH-MOVING EQUIPMENT



New Aids to the Constructor

MANUFACTURERS' LATEST DEVELOPMENTS IN EQUIPMENT AND MATERIALS

Full-Circle Shovel

Claiming to be the first practical full-circle, mobile, one-man-operated ½-yd. power shovel, the new "Byers Traveler"

derives its name from its specially engineered short-coupled lower chassis, which permits 360 deg. operation. Timken Detroit axles, Ross steering gear unit and Vickers hydraulic ram to augment hand steering control are employed.

The 8-ft. chassis width meets state highway regulations and the 9-ft. wheel base permits digging over the front and rear of the machine. Forced oil lubrication of all enclosed gears and "Airflex" clutches are featured.—*The Byers Machine Co., Ravenna, Ohio.*

• • •

Conduit Base

To meet postwar demands for electrical equipment and wiring of buildings, a new Erecto-Luxtite conduit base is available. Metal base fronts, 10 ft. long, have duplex knockouts on 40-in. centers, but special spacing can also be provided. Inside and outside corners can be mitered on the job.

The front panel is designed to slip on and off without splicing plate or screws. A rattail file is said to be the only tool necessary to make semi-circular openings for telephone connections.—*Charles E. Barnes & Son, 4320 Osage Ave., Philadelphia 4, Pa.*

• • •

Welding Film

To minimize adherence of welding spatter to metal and to reduce cleaning time, a new "Non-Spatter" liquid film is said to be very effective. Field tests indicate that welding can proceed whether the film is wet or dry and that paint priming coats may be applied over it. One application of film is effective for multiple-pass welding. If applied to parts prior to being normalized, oxide film and ordinary scale are easily removed after heat treating, it is claimed.

This substance, which can be sprayed or painted on, will freeze, but with no alteration of its properties; it can be removed by washing with water. Available in 5-gal. cans, the film should be diluted with three parts of water.—*The Lincoln Electric Co., Cleveland, Ohio.*

• • •

Truck Mixer

Transmission, drum mounting and charging hopper improvements are incorporated in a new line of Hi-Dump truck mixers. An enlarged drum opening, and a large discharge gate on the hopper, which opens with a half-turn of a control wheel, increase charging and discharging speeds. Light-pressure synthetic rubber ring seals may be quickly changed without removing the hopper.

The water tank down on the main frame has a low center of gravity; the metering intake is locked in any set position by a worm; and two water bells spray the water to both ends of the drum. One enclosure houses all parts of the unit, with large side doors for easy access.—*The Jaeger Machine Co., Columbus 16, Ohio.*

• • •

Countersunk Pipe Seal

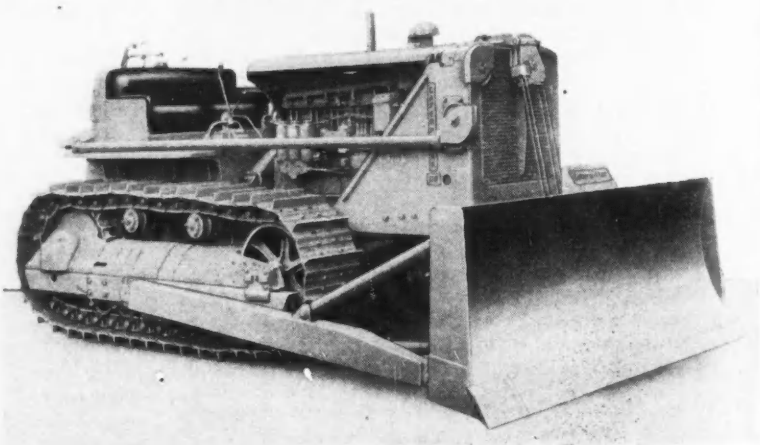
Tough plastic is used in a new line of countersunk pipe seals and thread protectors because it is light, takes accurate and durable threading and excludes dirt, moisture, etc.

The square sockets of the new countersunk pattern fit commercial square bars of standard sizes—⅛, ¼, ⅜, ½, ¾ and 1 in.—*American Molded Products Co., 1644 North Honore St., Chicago 22, Ill.*

• • •

Portable Fire Extinguisher

Fast acting and portable, the new Alfite Speedex fire extinguisher is made in three sizes, Models 15, 10 and 4. The numbers indicate the pound capacity of the carbon dioxide gas. This unit is especially useful in putting out small oil or electrical fires, with no



Cable-Controlled Bulldozers

Now in production as a result of the lifting of WPB restrictions, Caterpillar-controlled bulldozers and scrapers will shortly be available. Bulldozer Model 8S, illustrated, for use with tractor Model D8, has box-type moldboard, and a 104-in. long center section cutting edge, of high carbon steel. The maximum blade pitch adjustment is 10 deg., and the maximum blade tilting adjustment is 12 in.

Among the outsanding advantages of Caterpillar bulldozers are: balanced design, great capacity, rigid construction, elimination of "A" frame, reinforced blade, easy digging, enclosed operating cables, long-life cutting edges, easy blade adjustments, quick mounting, correctly grooved sheaves, long cable life, safe operation, fine visibility, high lift, low drop, straight or angling cut, unit manufacture and one service source.—*Caterpillar Tractor Co., Peoria, Ill.*

For more years than civic pride could unblushingly remember, Cleveland's Municipal Stadium hadn't been painted. However, the war had a lot to do with that.

Now, Cleveland again "points with pride". What a difference a coat of aluminum paint has made on the exterior steel.

The fact that the aluminum paint was made with Alcoa Albron pigment is one reason why the city fathers can forget about painting the stadium windows and spandrels again for a long time. This superior pigment is made from metal that analyzes 99+% pure aluminum. It is tested and retested, during manufacture, to check it for good leafing properties, particle size, color and uniformity in all respects.

This extra-particular care in processing Alcoa Albron is what makes it a better pigment . . . and gives you a better paint when it's mixed in proper amount in the proper vehicle.

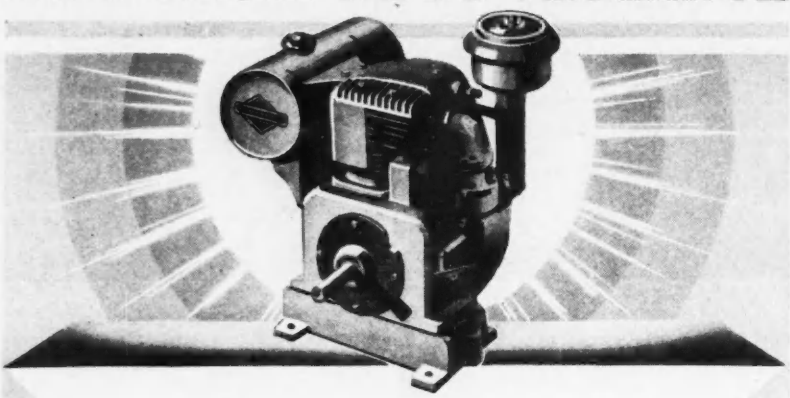
Be particular yourself. When you buy aluminum paint, ask for paint made with Alcoa Albron. You'll get more years of good looking protection for your money.

Cleveland fans are headed for two treats . . . a newly painted Municipal Stadium and a 4-hit victory pitched by "Rapid Robert" Feller.

ALCOA ALBRON PASTE
for Aluminum Paint

ALCOA ALUMINUM

POWER WITH
BRIGGS & STRATTON
Air-Cooled Engines
YOUR ASSURANCE OF
MAXIMUM-PERFORMANCE



In a brilliant record of dependable and economical operation — well above 2¼ MILLION Briggs & Stratton 4-cycle gasoline engines have *earned undisputed* recognition as "preferred power" the world over. Current models are the result of skill and experience gained during more than 26 years of *continuous production* of single-cylinder Air-Cooled engines—and constant advancements in design and precision manufacture. These distinctive Briggs & Stratton advantages are your assurance of *maximum performance*—the *right power*—whether you build, sell, or use gasoline-powered appliances, machinery, or industrial equipment.

BRIGGS & STRATTON CORPORATION
Milwaukee 1, Wisconsin, U. S. A.

Air-Cooled Power

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

loss of gas on anything but the fire itself.

The valve lever directly above the carrying handle can be quickly opened and closed by pressure and release of the hand grip; for continuous operation a D-yoke ring slips over the operating lever.—*American-LaFrance-Foamite Corp., Elmira, N. Y.*

• • •

Portable Desk

Sturdy and mobile, a new steel desk, Model 2131-15, has many industrial uses. It stands on 3-in. swivel casters

and has a positive brake attachment.

The desk hood provides adequate storage space and a smooth 30-in. desk top has a 3-in. overall slope. There is a spacious drawer with a lock for important papers. The desk is 34½ in. wide, 30 in. deep and 53 in. high (43 in. high in front).—*Lyon Metal Products, Inc., Aurora, Ill.*

• • •

Goggle Spray Station

Of compact size, requiring only minimum wall space, a new Sani-Spray goggle station is easy to use and tamperproof. The cabinet contains a refillable quart jar of Sani-Spray, a supply of tissues and a built-in receptacle for used tissues. Simple push-button control releases a predetermined mist from an orifice at one side.—*Allen Optical Co., Buffalo 2, N. Y.*

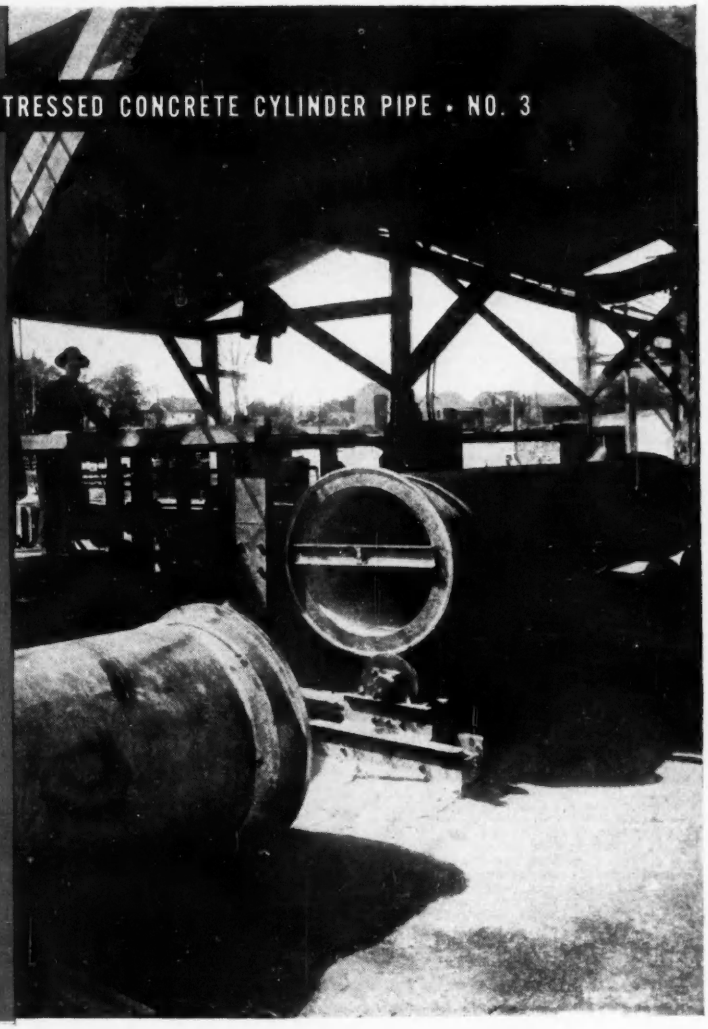
• • •

Power Conveyor Drive

A self-contained assembled unit, built solidly in an iron frame, the new "Power-Pac" power conveyor drive measures 15x24x17 and weighs only 167 lb. The unit, to be bolted to the chassis of any piece of conveying equipment, consists of motor, driving rolls, switch speed reducers if desired, controls and gears.—*Island Equipment Corp., 101 Park Ave., New York, N. Y.*

ADVANTAGES OF PRESTRESSED CONCRETE CYLINDER PIPE • NO. 3

Greater Elasticity



● Lock Joint Prestressed Concrete Cylinder Pipe has many advantages . . . and among its most important qualities is GREATER ELASTICITY.

Tests have proven that *prestressing* produces elastic properties in a reinforced concrete structure, previously unattainable with conventional designs, and it is only through *prestressing* that the wider range of elastic properties of high tensile wire can be used to the greatest advantage. The winding of the wire under tension around the "core" causes an initial compression in the concrete lining, thereby giving the finished pipe a much greater range of elasticity to withstand internal pressure, water hammer and overloads.

During the past few years, the Lock Joint Pipe Company has installed hundreds of thousands of feet of Prestressed Concrete Cylinder Pipe with several hundreds of thousands of feet now under contract. When you specify this high pressure pipe you can count 100% on strength, economy and performance.

A Hazen-Williams Hydraulic Slide Rule will gladly be sent upon request with our compliments.

LOCK JOINT Reinforced Concrete PRESSURE PIPE

LOCK JOINT PIPE COMPANY

Established 1905

P. O. BOX 269, EAST ORANGE, NEW JERSEY

Denver, Colo. · Chicago, Ill. · Kenilworth, N. J. · Kansas City, Mo. · Rock Island, Ill. · Joplin, Mo. · Valley Park, Mo. · Cleveland, Ohio · Hartford, Conn. · Navarre, Ohio

SCOPE OF SERVICES *Lock Joint Pipe Company specializes in the manufacture and installation of Reinforced Concrete Pressure Pipe for Water Supply and Distribution Mains in a wide range of diameters as well as Concrete Pipe of all types for Sanitary Sewers, Storm Drains, Culverts and Subaqueous lines.*

Worthington-Ransome Blue Brute Distributors

By referring to the advertisement on page 173 you'll learn the meaning of the (1), (2) or (1-2) beside their names.

Ala., Birmingham (1–2) J. D. Pittman Tractor Co.
Ariz., Phoenix, Lee Redman Co.
Ark., Fort Smith (2) R. A. Young & Son
Little Rock (1) Kern-Limerick, Inc.
Little Rock (2) R. A. Young & Son
Calif., Los Angeles (1) Garlinghouse Bros.
Los Angeles (1–2) Smith Booth Usher Co.
San Francisco (1-2) Coast Equipment Co.
Colo., Denver (2) John N. Meade
Denver (1–2) Power Equipment Co.
Conn., Hartford (2) The Holmes-Talcott Co.
New Haven (1) W. I. Clark
Waterbury (1) Contractors Supply Co.
D. C. Washington (1) M. A. Deetsch Machinery Co.
Fla., Miami (1–2) Allied Equip., Inc.
Tampa (1–2) Epperson & Co.
Orlando (1–2) High Equip. & Supply Co.
Ga., Atlanta (1–2) Tractor & Machinery Co.
Savannah (1) Morgans, Inc.
Ida., Boise (1–2) Olson Manufacturing Co.
Ill., Chicago (1–2) Chicago Construction Equipment Co.
Chicago (1–2) John A. Roche
Chicago (1) Thomas Hoist Co.
Ind., Fort Wayne (1) American Steel Supply Co.
Indianapolis (2) Reid-Holcomb Co.
Iowa, Des Moines (2) Electric Eng. & Const. Co.
Ky., Harlan (2) Hall Equipment Sales Co.
Louisville (2) T. C. Coleman & Son
Louisville (2) Williams Tractor Co.
Paducah (1) Henry A. Petter Supply Co.
La., New Orleans (1) Ole K. Olson Co.
New Orleans (2) Wm. F. Surgi Equipment Co.
Maine, Portland (1–2) Maine Truck-Tractor Co.
Md., Baltimore (1) Stuart M. Christhilf & Co.
Baltimore (2) D. C. Eighlestone, Inc.
Mass., Boston, Allston (1–2) Clark-Wilcox Co.
Cambridge (2) Field Machinery Co.
Mich., Detroit (1) T. G. Abrams
Detroit (2) W. H. Anderson Co., Inc.
Dearborn (2) T. G. Abrams
Flint (2) Gransden-Hall & Co.
Muskegon (1–2) Lakeshore Machinery & Supply Co.
Minn., Minneapolis (1–2) Phillippi-Murphy Equipt. Co.
St. Paul (1–2) D. L. O'Brien
Miss., Jackson (1–2) Jackson Road Equipment Co.
Mo., Clayton (1–2) The Howard Corporation
Kansas City (1) Brown-Strauss Corp.
Kansas City (2) Machinery & Supplies Co
St. Louis (2) W. H. Reaves
Montana, Billings (1–2) Interstate Truck & Equip. Co.
Helena (1–2) Caird Eng. Works
Neb., Lincoln (1) Highway Equipment & Supply Co.
N. J., Hillside (2) P. A. Drobach
Newark (1) Johnson & Doalaman
North Bergen (2) American Air Compressor Corp.
N. M., Albuquerque (1–2) Bud Fisher Co.
Roswell (2) Smith Machinery Co.
N. Y., Albany (1–2) Milton-Hale Machinery Co.
Buffalo (2) Dow & Co., Inc.
New York (2) Air Compressor Rental & Sales
New York (1–2) Hodge & Hammond, Inc.
New York (1–2) Railroad Materials Corporation
Olean (2) Freeborn Equipment Co
N. C., Raleigh (2) Carolina Tractor & Equipment Co.
Raleigh, (1) Smith Equip. Co.
N. D., Fargo (1–2) Smith Commercial Body Works, Inc.
O., Cincinnati (1–2) Fine Equipment Co.
Cleveland (2) S. M. Clancey
Cleveland (1) H. B. Fuller Equipment Co.
Cleveland (2) Gibson-Stewart Co.
Marietta (2) Northwest Supply & Equipment Co.
Toledo (2) M. W. Kilcorse & Co.
Oklahoma, Okla. City (1–2) Townsco. Equip. Co.
Oregon, Portland (2) Andrews Equipment Service
Pa., Allentown (2) H. N. Crowder, Jr., Inc.
Easton (2) Sears & Bowers
Harrisburg (2) Amer. Equip. Co.
Oil City (2) Freeborn Equipment Co.
Philadelphia (1) Giles & Ransome
Philadelphia (2) Metalweld, Inc.
Pittsburgh (2) Atlas Equipment Corp.
Wilkes-Barre (2) Ensminger & Co.
Wilkinsburg (1) Arrow Supply Co.
York (2) George F. Motters Sons
S. C., Columbia (1–2) Smith Equipment Co.
Tenn., Knoxville (2) Wilson-Weesner-Wilkinson
Knoxville (1–2) Dempster Bros., Inc.
Tex., Dallas (1–2) Shaw Equipment Co.
El Paso (2) Equipment Supply Co.
El Paso (1) Mine and Smelter Supply Co.
Houston (2) Dye Welding Supply Co.
Houston (1) McCall Tractor & Equipment Co.
San Antonio (2) Patten Machinery Co.
San Antonio (1) San Antonio Machine & Supply Co.
Utah, Salt Lake City (1–2) Landes Engineering Co.
Vt., Barre (1–2) A. M. Flanders, Inc.
Va., Richmond (1–2) Highway Machinery & Supply Co.
Wash., Seattle (2) Star Machinery Co.
Spokane (2) Andrews Equipment Service
W. Va., Charleston (1) Clyde P. Beckner, Inc.
Fairmont (2) Interstate Engineers & Constr., Inc.
Wisc., Milwaukee (1–2) Drott Tractor & Equip. Co., Inc.
Wyoming, Cheyenne (2) Wilson Equipment & Supply Co.

Bar Bar Brutes

Worthington Pump and Machinery Corp.

Worthington-Ransome Construction Equipment Division
Holyoke, Massachusetts

MEN AND JOBS

Rear Admiral Carl H. Cotter (CEC) USN, the first officer-in-charge of construction of the Jacksonville Naval Air Station, has returned recently from his duties as director, Pacific Division, Bureau of Yards and Docks, U. S. Navy in the Pacific.

With 27 years in the Civil Engineering Corps behind him, Rear Admiral Cotter has served in all types of Navy civil engineering jobs, including that of public works officer at the operating base at Norfolk, Va., and superintending civil engineer in 1942, representing the Chief of the Bureau of Yards and Docks in a southern area.

William L. Crow has returned to the presidency of William L. Crow Construction Co. after serving three years and four months in the U. S. Engineer Corps. Called to active duty in May, 1942, as a second lieutenant in the Reserve Corps, he went overseas in December, 1942, and served in Iran, France and Germany as executive officer of the 334th Engineer Special Service Regiment, receiving the Bronze Star Medal. While in Germany his regiment constructed bridges across the Rhine and Danube River and reconstructed several hundred miles of the Reich Autobahn. He recently returned to the United States as a major and was placed on inactive duty.

The Office of the Chief of Engineers has established a new maintenance division headed by **Col. Donald J. Leehey**, recently returned from overseas. The division will have technical supervision of the maintenance and repair of all military equipment items of standard supply and issue by the Corps of Engineers; such nonstandard items of construction equipment as may be repaired or rebuilt in engineer facilities operated under division engineers; and such items of nonengineer supply as may be assigned by higher authority as a maintenance responsibility of the Corps of Engineers. The new division will consolidate a number of functions hitherto carried out by other agencies.

Col. D. J. Leehey

J. C. Stevens is now head of the division of water control for Dade County, Fla. He entered the U. S. government service in 1934 and served as cartographic, agricultural and hydraulic engineer for the Soil Conservation Service in southern states. From 1942 until Sept. 1, 1945, he was project engineer for the Everglades project of the Soil Conservation Service.

Capt. G. K. Carnes, a civil engineering graduate of Texas A. & M. College, after a tour of duty with the Corps of Engineers, U. S. Army, in the southwest Pacific, is an instructor of engineering subjects in the advanced section of the engineering department at Fort Belvoir, Va.

R. C. Kenmir is now engaged in the design of water treatment plants for James M. Montgomery, consulting engineer of Los Angeles, Calif. He was previously employed by the Bureau of Yards and Docks at Washington, D. C., where he was in the sanitation section of the bureau's construction department.

G. H. Bittle has been appointed assistant to chief engineer H. E. Bailey of the Oklahoma state highway department. Mr. Bittle was formerly highway engineer for the Public Roads Administration.

E. M. Beardslee, formerly city manager of Deland, Fla., has accepted a similar position at Fernandina. While he was at DeLand, Mr. Beardslee was successful in master-planning the sanitary sewer system for the entire city, and in planning the water system through 1965, including additional storage facilities.

Louis P. Booz, consulting engineer of Perth Amboy, N. J., has been selected to make a survey and draw up plans for the construction of a $100,000 incinerator in Lowell, Mass.

H. St. G. T. Carmichael, Jr., former director of the division of planning, has been made first assistant chief engineer of the Kentucky State Highway Department, a new office. He will be responsible for planning, design, construction, maintenance and rural highways. **T. R. Lannon,** execu-

THIS "LIVE BOOM" PAVER LOWERS COSTS

Let's consider the unique advantages of the boom on a standard 34-E Ransome Blue Brute "Dual Drum" Paver to see why you can lay more yardage . . . more accurately . . . with less manpower . . . than with any other paver.

Because this boom is really a "live boom" just like your crawler crane, it can be power-elevated to allow 9 ft. clearance under the bucket. And the paver can be operated *continuously* with the boom in the elevated position.

Think what that means. Whenever you want, or as often as you want, you can concrete retaining walls, abutments, headwalls, etc. in one operation *at the same time you lay the slab.* You eliminate the extra expense of doing those operations separately.

Moreover, because this "live boom" *spreads as it swings* it covers wider area with each batch . . . cuts down on costly hand shoveling.

OTHER BLUE BRUTE PLUSSES

In addition, a Blue Brute "Dual Drum" Paver has the fastest-charging, self-cleaning skip . . . hydraulically-controlled bucket, eliminating split batches . . . metal-to-metal spiral cut-off for precise water measuring . . . mechanically-operated batchmeter for all-season accuracy. These and other features are described in detail in Bulletin 208. Write for it.

24RS-3

KNOW YOUR BLUE BRUTES

Your Blue Brute Distributor will gladly show you how Worthington-Ransome Blue Brute construction equipment will put your planning on a profitable basis and prove that *there's more worth in Worthington-Ransome.* Act now! His name is listed on page 172. The number beside his name indicates the Blue Brutes he handles.

1.
Blue Brutes include: Pavers, Concrete Spreaders**, Concrete Mixers, Concrete Placing Equipment, Big Mixers, Finishing Machines**, Pneumatic Placing & Grouting Equipment, Truck Mixers, Plaster & Bituminous Mixers, and accessories.

2.
Blue Brutes also include: Diesel, gasoline and electric driven Portable Compressors from 60 to 500 cu. ft. capacity in mountings to suit all jobs; Rock Drills and Air Tools in a wide range of weights and sizes; Contractors' Pumps.**

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Banded together in a united effort to simplify the distribution and servicing of construction machinery—that is the purpose of the

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Wherever you see displayed the A.E.D. seal you know that here is a well-established, soundly financed organization of men who know equipment, and its application.

Here are engineers who can recommend the right machinery for the job—Service men, trained in factory methods of rebuilding and repair—Parts Specialists, who know what is available; how and when to recommend the making of critical parts.

Over 600 A.E.D. distributors located strategically, together with their many branches from coast-to-coast, will help make your equipment last until new machines are released.

Write for information about other A.E.D. Services.

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tive assistant to the state highway engineer, has been promoted to assistant chief highway engineer and will succeed Mr. Carmichael as director of the division of planning. Mr. Carmichael is a graduate of Virginia Military Institute where he taught engineering, and also of the Harvard School of Business Administration. He has served with the Public Works Administration as chief engineer for Kentucky, and later as assistant regional engineer for Kentucky, Tennessee and Virginia. Formerly he was with the Virginia State Planning Board as supervisor of public works planning.

Corwin Rummel, Olympia, is departmental safety engineer for the Washington state highway department, succeeding **Richard Linton,** who was transferred to Wenatchee as maintenance engineer. **James Marshall** of Seattle was named departmental maintenance engineer, succeeding Normal Hill, resigned. **Roy Green** has resigned as district construction engineer at Olympia.

W. C. Sechrist is a designing engineer with Frederick Snare Corp. at Havana, Cuba. He had previously been an engineer at the Panama Canal and with the U. S. Engineers in Puerto Rico.

Nemmers and Clark, consulting engineers of Des Moines, Iowa have announced the association of their engineering firm with **George A. Spooner,** architect, under the name of Nemmers, Clark and Spooner.

Commander Louis S. Dozier, (CEC) USNR, of Macon, Ga., who has been directing all Seabee operations at the fleet activities in Tokyo Bay, Japan, during the occupation, will return soon. The 136th Naval Construction Battalion, which he commands, landed at Yokosuka Naval Base, Tokyo Bay, on Aug. 30, with the original landing force of the U. S. Third Fleet, to which it had been attached since leaving Guam. The performance of thte 136th Naval Construction Battalion (the first Seabee outfit to set foot on the Japanese homeland), during the early occupation period, and prior to the formal surrender, resulted in Commander Dozier being cited by Admiral William F. Halsey, and he was awarded the Commendation Ribbon.

Edgar W. Blom, lieutenant colonel on terminal leave from the Army Corps of Engineers, has been named city manager of Redwood City, Calif. He was graduated from Iowa State College in 1929 with a degree in civil engineering. He joined the Iowa State

MIX and SPREAD SOIL CEMENT IN *One* OPERATION?

Sure! WITH A WOOD ROADMIXER

★ **HERE ARE THE *Facts!***

The Wood Roadmixer is the pioneer and leading travel plant method of rapid, low cost, high quality pavement construction. It is pulled and powered by a standard crawler tractor. Supply truck is towed behind or parallels the mixer. The Wood Roadmixer is made in two sizes, handling up to 8 cu. ft. windrows.

Grade the surface to be paved and windrow materials to be mixed into equalized windrows. Proportion cement on windrows ahead of mixer either by bulk distribution or by sack. Make *ONE* pass with a Wood Roadmixer, adding correct amount of water, then spread—all in one operation.

That's a typical soil cement operation with a Wood Roadmixer—and it's a typical operation on road mix surfacing, mix-in-place asphalt base, flexible base or any type of stabilized base, using emulsions, road oils, tars, etc.

Sounds simple, doesn't it? And it is, because the Wood Roadmixer is a complete traveling mixing plant. It uses local or native materials, requires only two men on a normal job, ties up a minimum of equipment and produces from 250 to 350 tons per hour of ready-to-spread mix. The result is less cost per square yard or per ton—*as much as two-thirds less!*

That's why you should know *all* about the Wood Roadmixer. See your nearest dealer or write direct for literature and prices.

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BOX 32, 6900 TUJUNGA AVE. **NORTH HOLLYWOOD, CALIF.**

Low in sensitivity to ordinary electric light, Photo-Arc can be printed in a normally lighted room — even in your drafting room.

Peerless Photo-Arc reproductions speed up reconversion planning

Now you can make any type of contact photo-reproduction with new ease, new speed, new standards of quality:

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Moreover, every kind of Photo-Arc reproduction can be made on your blueprint machine.

Or, you can obtain a Photo-Arc printer at surprisingly low cost.

For further information write for Bulletin 12E

INDUSTRIAL PEERLESS PHOTO PRODUCTS

Highway Commission, of which he was assistant administrative engineer when he resigned, to become assistant city manager in Ames, ten years later, where he served until he entered the service in 1942. With the rank of major, Blom was assigned to the Rock Island engineering district, where as assistant area engineer, he supervised construction of the $21,000,000 Green River ordnance plant at Dixon, Ill. In 1943 he was sent overseas.

Revoe C. Briggs, hydraulic engineer in the water resources branch of the U. S. Department of the Interior, San Francisco office, has been loaned to the Venezuelan government for one year by the U. S. Geological Survey. Mr. Briggs' headquarters are at Caracas where he is technical adviser in hydrology in the office of the director of Irrigation and National Cartography.

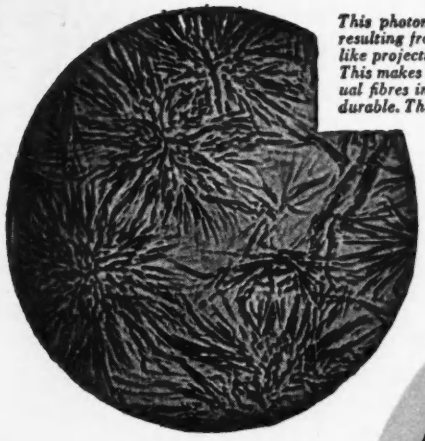
Ralph C. Chaney has retired from active duty with the Ohio Department of Highways, and is living at Interlachen, Fla. For five years prior to retirement, as regional planning engineer he had conducted surveys and studies for a comprehensive express highway plan for metropolitan Cleveland and prepared contract plans for some $6,000,000 of work toward the projected system. Mr. Chaney's previous work included that of county planning engineer at Cleveland; state engineer inspector for Ohio, in the Public Works Administration; and many years as engineer for Columbus on design and construction and as planning engineer.

William H. Day, on leave from his place as city engineer of Rockford, Ill., received the Bronze Star for his part in building the Victory Bridge across the Rhine at Duisburg in six days, fifteen hours. He is a major in the Engineer service.

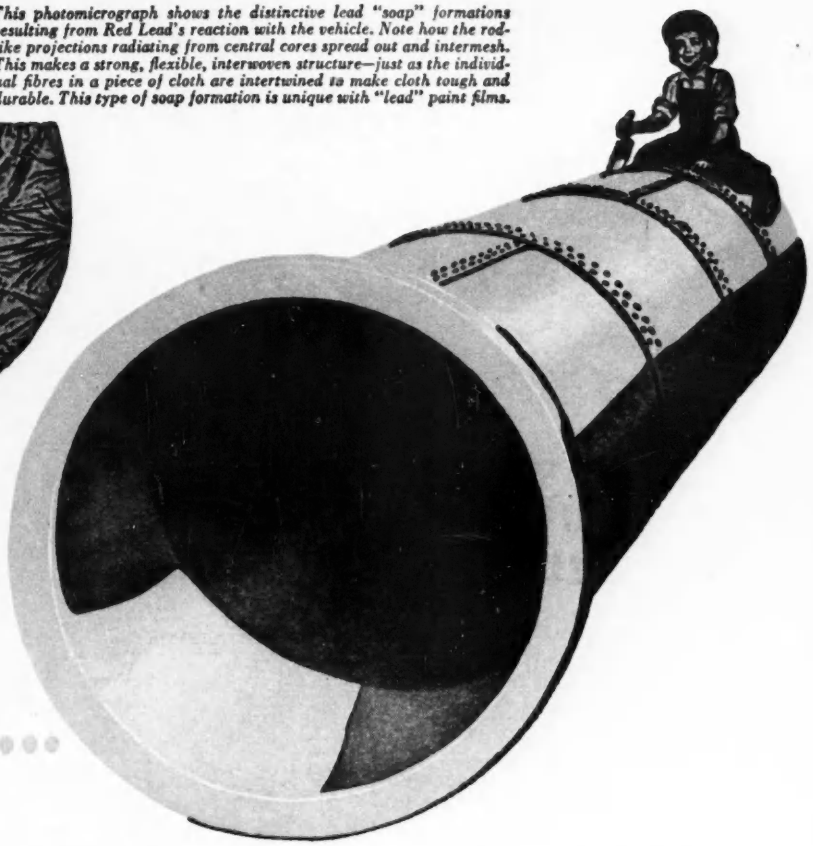
Raymond A. Coolidge and Roy W. Stockey, engineering consultants, have opened offices in Topeka, Kan. Coolidge recently completed three and a half years service with the U. S. Engineer's Office in Kansas City. Stockey has moved to Topeka from Ottawa, Kan., where he was a partner in the firm of Washburn and Stockey.

Anthony D. Grieco, Watertown, N. Y., is going to Venezuela for the Raymond Concrete Pile Co. as labor supervisor. He had been grade supervisor for the D. W. Winkleman Co., in the construction of the Watertown airport at Dexter, N. Y.

Lt. Comdr. Thomas F. Bowe has formed a partnership with **Lt. John G.**



This photomicrograph shows the distinctive lead "soap" formations resulting from Red Lead's reaction with the vehicle. Note how the rod-like projections radiating from central cores spread out and intermesh. This makes a strong, flexible, interwoven structure—just as the individual fibres in a piece of cloth are intertwined to make cloth tough and durable. This type of soap formation is unique with "lead" paint films.



unique LEAD SOAPS...

another important reason why RED LEAD means Extra Rust Protection

Why is Red Lead outstanding as a metal protector?

One of the major reasons is this pigment's remarkable ability to impart to the paint film strong, tough, intertwining lead "soap" formations—as shown in the photomicrograph above.

These unique lead "soaps" improve the paint film in many ways. For one thing, they form a dense, intermeshing matrix which restricts the passage of water through the film. And rusting does not take place without the presence of moisture.

For another, they *mechanically* reinforce the film, giving it extra *strength* and *toughness.*

And again, Red Lead "soaps" contribute all-important *elasticity* — allowing movement along their intermeshing projections. This action helps prevent the ruptures to which a hard, unyielding film is subject. Moreover, when a paint film dries and ages, decomposition of the vehicle sets in. But, because of Red Lead's ability to combine with the decomposition products and form soaps, it increases both the durability of the paint film and its adhesion to the base metal.

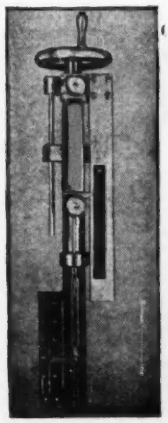
Red Lead's extra strength, toughness and elasticity are demonstrated by the tensile strength test below and substantiated by exhaustive research and field service.

Remember, too, that Red Lead is compatible with practically all vehicles commonly used in metal protective paints, including phenolic and alkyd resin types.

Specify RED LEAD for All Metal Protective Paints

The value of Red Lead as a rust preventive is most fully realized in a paint where it is the only pigment used. However, its rust-resistant properties are so pronounced that it also improves any multiple pigment paint.

* * *



In this tensile strength tester a typical Red Lead paint film has been stretched 18% without breaking. In withstanding this elongation it has maintained a load of 920 grams. Any film that exhibits these characteristics has unusual strength, toughness and elasticity. As metals expand and contract only a fraction of one percent, this film would adhere under the most extreme conditions.

No matter what price you pay, you'll get a better paint for surface protection of metal, if it contains Red Lead.

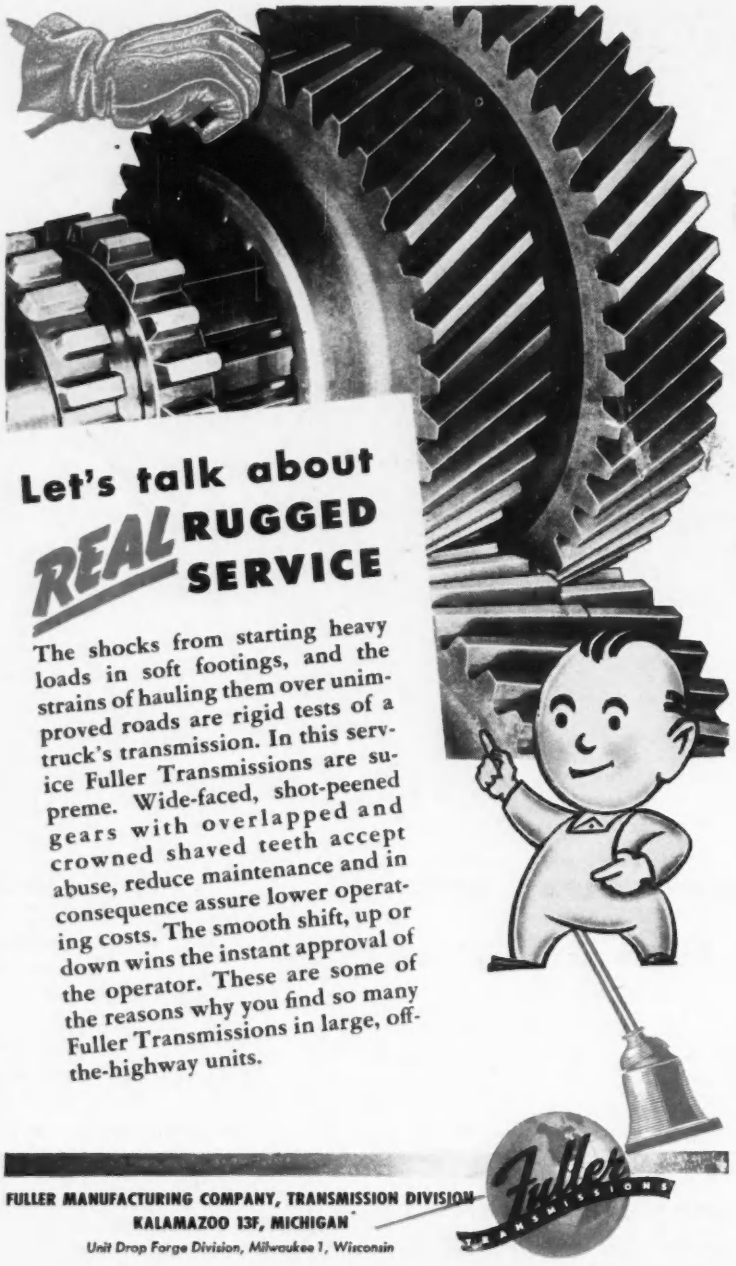
Write for New Booklet—"Red Lead in Corrosion Resistant Paints" is an up-to-date, authoritative guide for those responsible for specifying and formulating paint for structural iron and steel. It describes in detail the scientific reasons why Red Lead gives superior protection. It also includes typical specification formulas—ranging from Red Lead-Linseed Oil paints to Red Lead-Mixed Pigment-Varnish types. If you haven't received your copy, address nearest branch listed below.

* * *

All types of metal protective paints are constantly being tested at National Lead's many proving grounds. The benefit of our extensive experience with Red Lead paints for both underwater and atmospheric use is available through our technical staff.

NATIONAL LEAD COMPANY: New York 6, Buffalo 3, Chicago 80, Cincinnati 3, Cleveland 13, St. Louis 1, San Francisco 10, Boston 6 (National-Boston Lead Co.); Pittsburgh 30 (National Lead & Oil Co. of Penna); Philadelphia 7 (John T. Lewis & Bros. Co.); Charleston, W. Va. (Evans Lead Division).

DUTCH BOY RED LEAD


Let's talk about
REAL RUGGED SERVICE
The shocks from starting heavy loads in soft footings, and the strains of hauling them over unimproved roads are rigid tests of a truck's transmission. In this service Fuller Transmissions are supreme. Wide-faced, shot-peened gears with overlapped and crowned shaved teeth accept abuse, reduce maintenance and in consequence assure lower operating costs. The smooth shift, up or down wins the instant approval of the operator. These are some of the reasons why you find so many Fuller Transmissions in large, off-the-highway units.
FULLER MANUFACTURING COMPANY, TRANSMISSION DIVISION
KALAMAZOO 13F, MICHIGAN
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LA CROSSE

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SPECIFICATIONS ON REQUEST

LA CROSSE TRAILER & EQUIPMENT CO.

LA CROSSE, WISCONSIN

Albertson, USNR, and M. D. McCaffery under the name of Bowe, Albertson & Associates, engineers at 110 William St., New York City.

John A. Moran has returned to the Clay Sewer Pipe Association, Inc., Columbus, Ohio, after a year and a half as clay products business specialist of OPA in Washington, D. C. Prior to his assignment with OPA, Moran was district engineer of field operations in Ohio. He is now on the general office staff of the association at Pittsburgh, Pa.

Changes of personnel in the Washington State Highway Department were announced recently by Clarence Shain, newly appointed director. **Leonard Clark** will replace Lawrence Turnbill as personnel engineer; **Neal R. McKay** has temporarily taken over Henry Porak's duties as works control engineer; **Roy Tillman,** district engineer at Wenatchee will be new engineer of district 3, Olympia, succeeding George Mason; **Joe Hamilton,** Yakima district engineer, will fill Mr. Tillman's old Wenatchee post while **Tom Doyle,** construction engineer, will take over the post left vacant by Hamilton.

Richard Johnson has replaced William Yowell as county superintendent of highways, Macoupin County, at Carlinville, Ill.

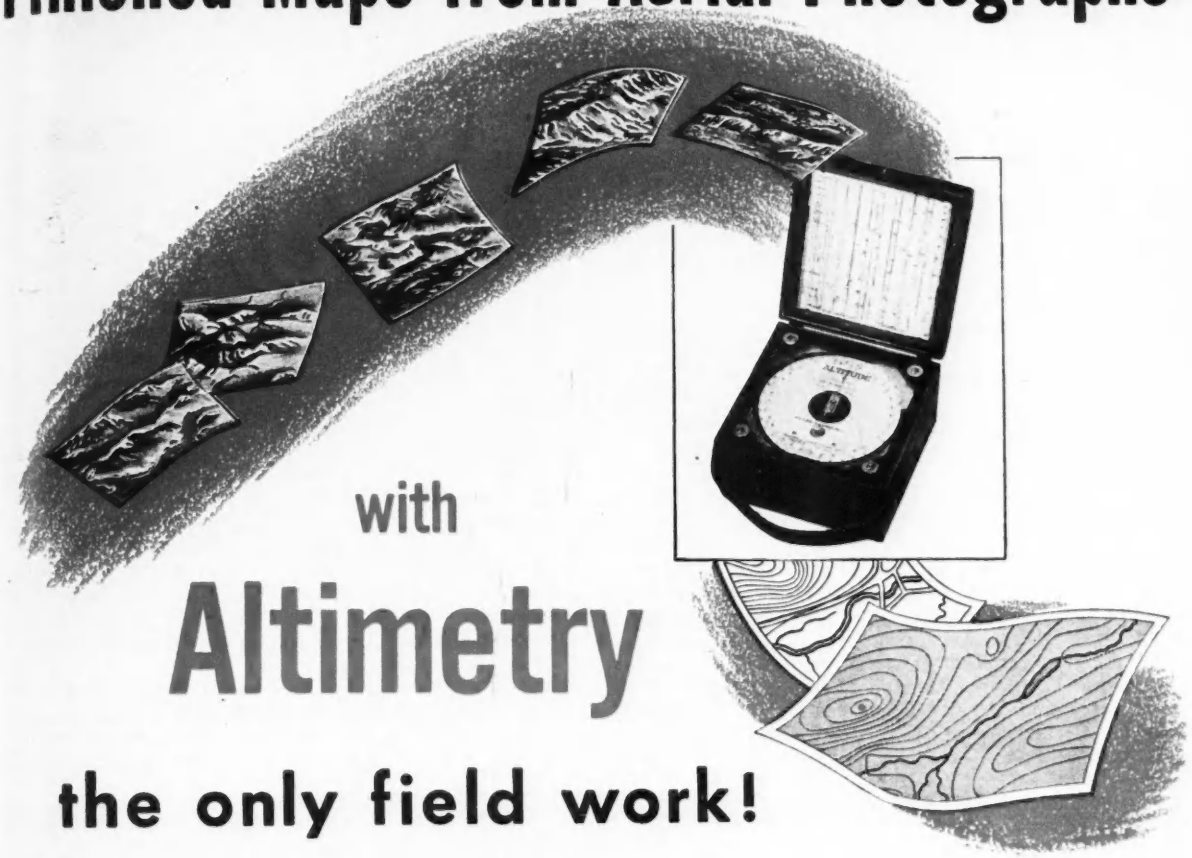
The Portland, Ore., school board has retained **William H. Jones,** formerly architectural engineer for the Portland District Army Engineers, as director of plant inspection and planning for a 3-year period. He will consult with Portland architects on the board's multi-million dollar school building program.

Rod Ryker has been named supervisor of hydraulics in the Washington state department of conservation and development, succeeding **C. B. Shain,** newly-named state highway director. Ryker has served as engineer for Okanogan and Kittitas counties and also has worked for the state highway department.

John C. Doucha, chief engineer of the J. A. Jones Construction Co., Charlotte, N. C., is in charge of construction of a 75-mi. highway being built by his firm between Guamote and Tambo in Ecuador. It will cost approximately $2,500,000.

O. C. Thompson, formerly sanitary engineer at Muskogee Army air field, Okla., is now instructor in the post engineer training school, sanitary division at Buckley Field, Denver, Colo.

Finished Maps from Aerial Photographs



with Altimetry

the only field work!

• *Horizontal* as well as vertical control data can now be obtained for any and all points from aerial photographs — with the accuracy required for map construction to all ordinary scales — by Precise Altimetry, with W&T Sensitive Altimeters.

Having the length and elevation of a base line the only necessary field work is the altimetry to determine elevations at control points. Conventional triangulation and traverse work is unnecessary — the work is speeded and costs are reduced.

A new publication, "An Application of Precise Barometric Altimetry to Aerial Photogrammetry" gives in detail the field procedure and computations required.

Write for a copy of this bulletin and technical literature on the Wallace & Tiernan Sensitive Altimeter.

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PRODUCTS, INC.
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Elections and Activities

John Harris of Chicago was elected president of the Illinois Section of the American Water Works Association at its recent annual meeting. He succeeds Herbert White, Champaign. S. T. Anderson, Springfield, was chosen vice president for the forthcoming year and J. C. Moomau was elected trustee. O. T. Birkeness of Chicago is secretary-treasurer. A. E. Anderson, superintendent of water, Moline, Ill. received the Fuller Memorial Award for . . . "his constructive guidance and assistance to other water plant operators and for his practical demonstration of the state's mutual aid program of helping other cities."

The West Texas Chapter of Professional Engineers, Ft. Worth, has changed its name to the Ft. Worth Chapter of Professional Engineers. This was done because several chapters have been organized in west Texas towns and it is desired to avoid confusion.

The North Carolina Section of the American Waterworks Association and the North Carolina Sewage Works Association of the Federated Sewage Workers Association have elected the following officers: LeRoy I. Lassiter, Wilmington, chairman; Jas. A. English, Salisbury, vice-chairman; George S. Moore, Albemarle, secretary-treasurer; P. D. Davis, Durham, N. C., Trustee; D. McGregor Williams, Durham, director of the American Waterworks Association from the North Carolina Section; George S. Rawlings, Charlotte, director of Federated Sewage Workers Association from North Carolina Section.

The Washington State Reclamation Association, has elected George R. Thompson, Chehalis, president, with J. A. Weber, Quincy, first vice president and Howard Seivers, Everett, second vice president. Directors for a two-year term are J. W. Spangler and Tom D. Tyrer, Seattle; R. V. Welts, Mount Vernon; Ed Warner, Tacoma; F. K. Jones, Spokane; Frank Maupin, Kenewick; N. G. Barlas, Oroville; John Peirce, Bellingham, and J. K. Cheadle, Spokane. Directors elected for a one-year term are: John P. Neal, Olympia; F. N. Barrett; Seattle; J. C. Scott, Sequim; A. L. Thiele, Wenatchee; F. M. Lowden, Jr., Walla Walla; W. R. Rowe and H. L. Coffin, Yakima; R. L. Rutter, Ellensburg; Maurice Windus, Longview.

At the recent 12th tri-ennial reunion of the Engineering Alumni Association of the University of Toronto, Dr. Otto Holden, hydraulic engineer for the Hydro Electric Power Commission of Ontario, was elected president, to succeed M. L. Hastings. Over 500 engineering graduates of Toronto, from many parts of Canada and the United States, attended.

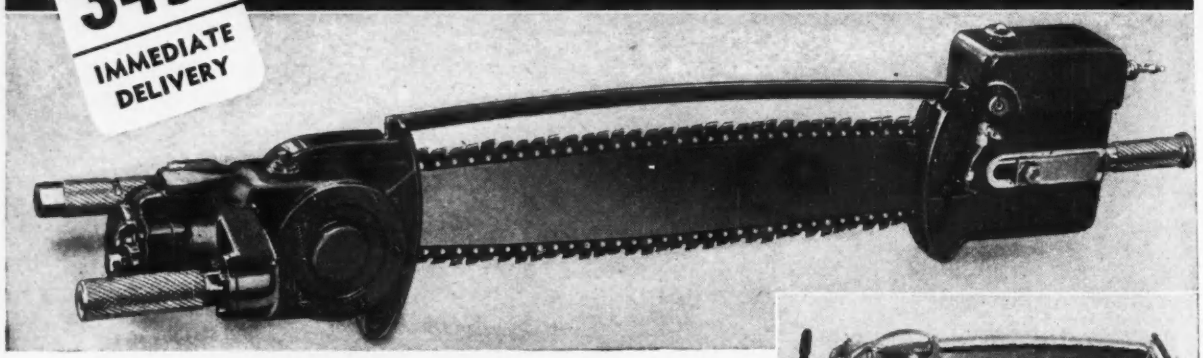
The North Carolina Society of Engineers, according to its president, L. W. Payne of Raleigh, has sent a resolution to Governor Gregg Cherry asking that a study be made of the possibility of raising salaries of engineers employed by the state. The society also has endorsed a proposal that county surveyors be appointed by county boards of commissioners.

Thomas B. Casey, chief engineer of the waterways division of the Illinois Department of Public Works and Buildings, has been appointed vice president for Illinois of the National Rivers and Harbors Congress, which was organized in 1901 to further a coordinated development of water and land resources.

The Tennessee Valley Section of the American Society of Civil Engineers and the East Tennessee Section of the American Society of Mechanical Engineers

$345.00 IMMEDIATE DELIVERY

IMPROVED and SIMPLIFIED DESIGN!



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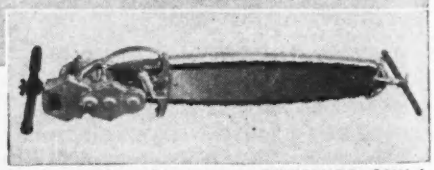
AIR MOTOR DRIVEN "TIMBERHOG" SAW

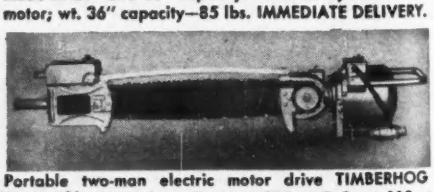
This two-man Portable Endless Chain Saw powered by a 3½ HP air motor, operating at 90 to 105 lbs. pressure (see above) is recommended for general construction, timber, railroad, mine, shipyard and plant maintenance work. Available in 24" capacity — weight 50 lbs. Price $345.00 F.O.B. Worcester, Mass.

REED-PRENTICE CORP.
TIMBERHOG
WORCESTER SAWS MASS., U.S.A.

Larger electric and new model one and two-man gas TIMBERHOG SAWS will soon be available. Handy TIMBERHOG saw chain sharpener is also available for immediate delivery.
"Original and largest manufacturers of portable timber saws — since 1927"



For heavy duty this two-man TIMBERHOG SAW is made in 24" and 36" capacity. Powered by 4.1 HP air motor; wt. 36" capacity—85 lbs. IMMEDIATE DELIVERY.



Portable two-man electric motor drive TIMBERHOG SAW, 1½ HP. Universal motor, 115 v. D.C. or 110 v. A.C., 24" capacity, weight 65 pounds. IMMEDIATE DELIVERY.

Douglas fir plywood PLYFORM concrete forms helped give a smooth, attractive, streamlined finish to this beautiful City Hall in Santa Monica, California. Architect was Joe Estep.

For Superior Performance in Concrete Forms - *specify* PLYFORM

Every panel of Douglas Fir Plywood PLYFORM carries a distinctive green edge-sealing — a mark of quick identification.

PLYFORM is a specialized grade of Douglas fir plywood manufactured to meet the particular needs of concrete form work. Highly water-resistant glues and cross-laminated construction give every panel a combination of strength and toughness. PLYFORM will support a load of 500 pounds per square inch on a 5/8" panel with joists 12" apart (deflection is less than 4/100" of an inch)—and as many as 15 reuses have been reported. Consider the other advantages* too, and you'll see why PLYFORM **does** give superior performance.

GENUINE
DOUGLAS FIR
PLYFORM
TRADE MARK REG. U. S. PAT. OFF.
Concrete Form Panel
D. F. P. A.
INSPECTED

This "grade trade-mark" appears on the face of every genuine panel of Douglas fir plywood PLYFORM.

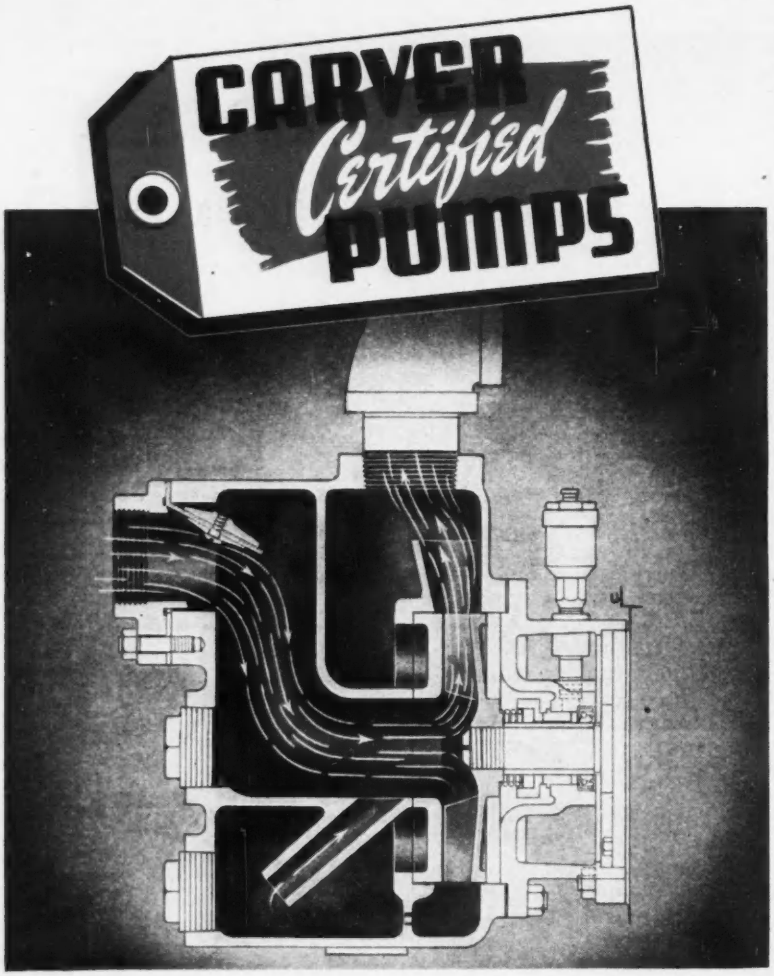
* PLYFORM REDUCES CONSTRUCTION COSTS!

Large, rigid panels of PLYFORM—4 x 8 feet in size, and from ½" to ¾" thick—go up quickly and easily. PLYFORM is readily worked either by hand or with power tools. Stripping is fast and simple. Joints and fins are minimized. Leakage is reduced and finishing costs are lessened because the sanded surfaces of PLYFORM panels give the concrete face a smooth, even appearance.

Technical information is contained in a booklet "Concrete Forms of Douglas Fir Plywood" — and Association engineers will be glad to work with you in solving particular problems.

Douglas Fir Plywood Association
Tacoma 2, Washington

For prices or delivery information see any lumber dealer in the United States. Every dealer will soon have plywood in stock.



Noted for trouble-free operation

● This cutaway view of a Carver Certified Pump shows why it has such a record for high, lasting performance. Note the smooth, unimpeded flow of water from suction to discharge, the scientific design of the recirculation tube. Exhaustive performance tests helped determine exactly the proper size, shape and angle of this vital part to provide fastest priming, peak efficiency and correct amount of recirculation to keep priming chamber free from clogging deposits of silt, sand or dirt. See your local Carver distributor for specifications or write direct.

THE CARVER PUMP CO.
Muscatine, Iowa

CARVER CENTRIFUGAL
Certified PUMPS

held a joint meeting on Nov. 10 at the Oak Ridge High School within the Clinton Engineer Works atomic bomb project. About 250 engineers were present. Col. K. D. Nichols, district engineer, Manhattan District, War Department, welcomed the group, and Maj. Thomas J. Rentenbach, executive assistant to the district engineer, spoke on "Construction and Administrative Problems of Oak Ridge". Following the meeting, there was a tour to points of interest around the project.

Joseph P. Schwado, city engineer for Milwaukee, Wis., has been elected a director of the national board of the American Water Works Association. Other officers of the Wisconsin section are: Harold Londo, superintendent of the Green Bay water department, chairman; John J. McCarthy, chemist of Racine water department, vice-chairman; and Verne Somers, superintendent of the Stevens Point water department, director.

H. S. Nicklin, city engineer of Guelph, Ont., was elected president of the Canadian Institute on Sewage and Sanitation at the recent annual meeting in Windsor, Ont. Nichol McNichol, engineer of Forest Hill Village, Toronto, was elected vice-president, and the following were elected trustees: C. G. R. Armstrong, consulting engineer, Windsor; G. H. Richards, city engineer, Brantford; D. Jack, city engineer, Kingston; and T. M. S. Kingston, city engineer, Chatham, all in Ontario.

Mason Garber has been elected president of the Winston-Salem, N. C., Engineers Club. He succeeds N. J. Cromer, and will be installed in January with these other new officers: Charles M. Sprinkle, vice president; Horace H. Vance, secretary; J. H. Sherrill, treasurer; and James Marshall and Luther Lashmit, directors.

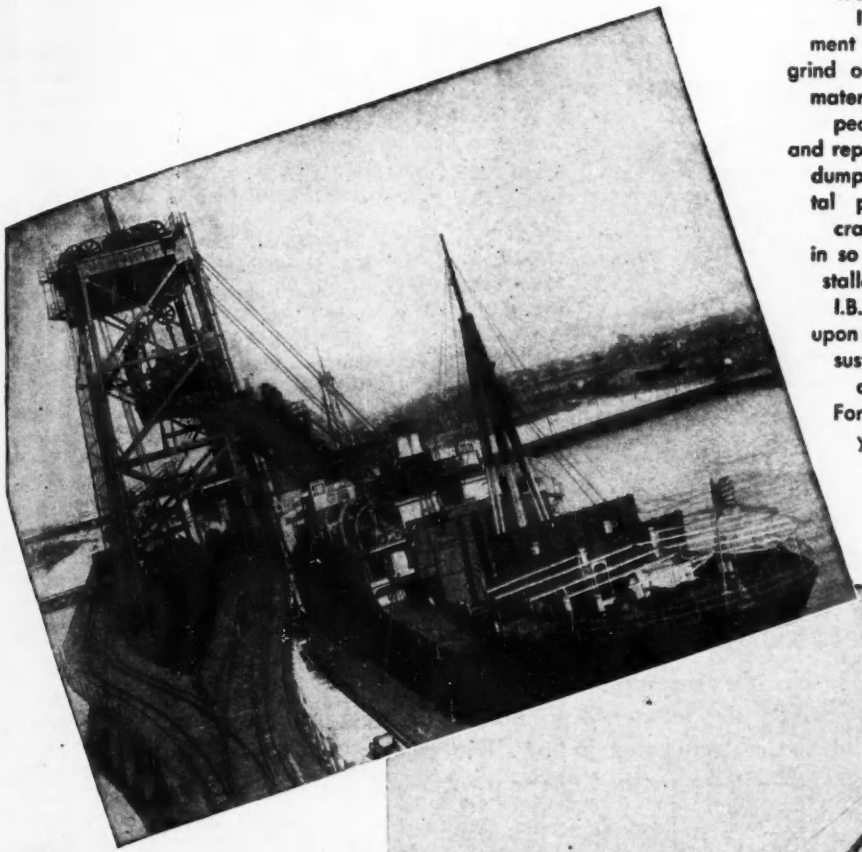
M. C. Peterson, Bemidji, Minn., has been elected president of the northwestern district, Minnesota Association of Professional Engineers. Other officers are J. A. Erickson, Thief Rover Falls, vice president; Harry Paine, Bagley, secretary and treasurer; A. L. Bye, Bemidji, member executive committee, and E. W. Downward, Bemidji, councilor.

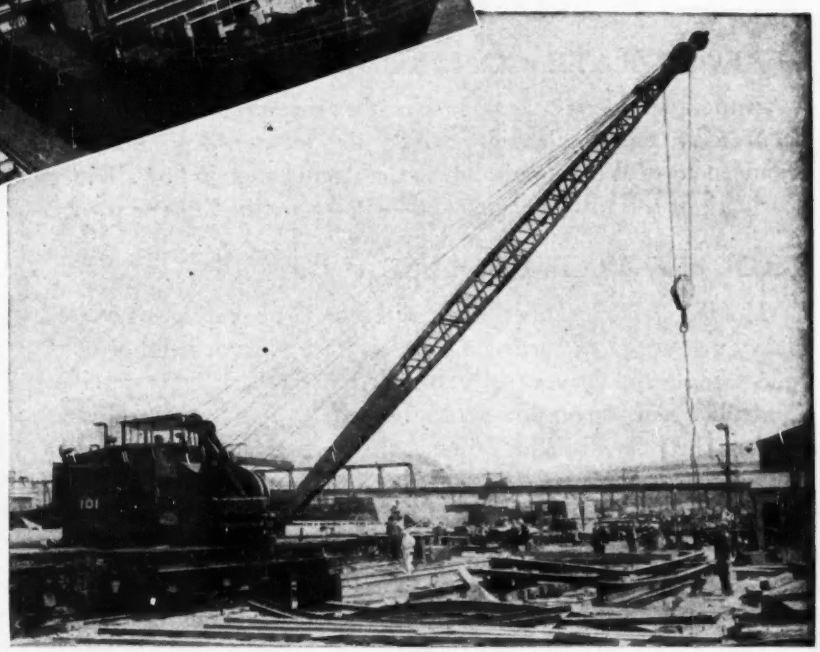
Col. John Jacobson, Jr., Manchester, N. H., has been re-appointed chairman of the State Water Resources Board, New Hampshire. He has been on leave of absence with the armed services.

George W. McCordic, organizing director of the Huron-Clinton Metropolitan Authority, has become president of

I. B. EQUIPMENT stands the gaff

Well engineered, ruggedly built I.B. material handling equipment stands up under the punishing grind of moving large quantities of materials day after day without repeated and costly breakdowns and repairs. That's why husky I.B. car dumpers, coal and ore bridges, portal pier cranes and locomotive cranes are handling the big jobs in so many important industrial installations throughout the world. I.B. equipment can be depended upon to handle materials for long sustained periods, with low operating and maintenance costs. For the dependable answer to your material handling problems, get the facts from I.B.





Above: I.B. High-Lift Electric Car Dumper emptying 120-ton capacity coal cars at the rate of sixty cars per hour.

Right: I.B. Locomotive Crane, known the world over for dependable, economical operation with hook, magnet, or bucket. Patented Monitor-type cab permits operator 360° visibility.

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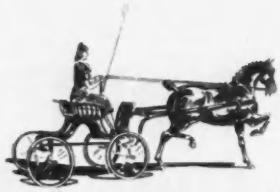
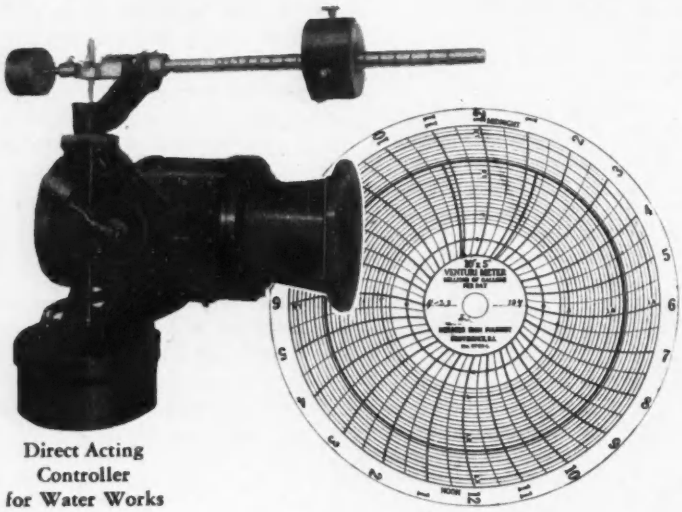
INDUSTRIAL BROWNHOIST CORP. • BAY CITY, MICH. • District Offices: New York, Philadelphia, Cleveland, Chicago • Agencies: Detroit, Birmingham, Houston, Denver, Los Angeles, San Francisco, Seattle, Vancouver, B.C., Winnipeg, Canadian Brownhoist Ltd., Montreal, Quebec.



Look to a Thoroughbred
for PERFECT CONTROL



Direct Acting
Controller
for Water Works

Reduced from actual chart.

PERFECT RATE CONTROL BECAUSE . . .

Annular pressure-averaging chamber measures the flow more accurately. Superior design avoids air pockets — no hunting. Balanced control valve responds to slightest change in flow. Every bearing is of the anti-friction type — no balancing links or pivots.

TROUBLE-FREE BECAUSE . . .

Molded, flexible rubber piston seal won't rub, catch or reverse. Heavy piston rod of hardened stainless steel will not bend or corrode. Single sturdy control valve blade is arched; can't buckle. Controller requires no power supply; self-actuated. Bronze-lined Venturi throat — Everdur bronze bolts and screws at no extra cost.

For descriptive bulletins, address Builders-Providence, Inc.
51 Codding St., Providence 1, R. I.

Builders Water Works Equipment: Controllers; Loss, Rate, Sand Expansion and Level gauges; Venturi Tubes, Nozzles and Instruments.

BUILDERS-PROVIDENCE

BUILDERS

the Michigan section of the American Society of Civil Engineers. Other new officers elected are: Chester L. Allen, first vice president; T. C. Hanson, secretary-treasurer.

Governor Proctor has appointed the following to represent Vermont on the New England Interstate Flood Control Committee: Alban J. Parker, Attorney General; Robert C. Lane, executive director, Vermont State Water Conservation Board; and Philip Shutler, research engineer.

For the current fiscal year, the board of governors of the Water and Sewage Works Manufacturers Association, Inc., is composed of: The Barrett Division, George B. McComb; The Dorr Company, Inc., R. S. Rankin; Dresser Manufacturing Division, H. P. Boncher; *Engineering News Record*, Albert E. Paxton; General Electric Co., S. W. Corbin; Hershey Manufacturing Co., William C. Sherwood; Hydraulic Development Corp., R. F. Hayes; Johns-Manville Corp., Charles A. McGinnis; Link-Belt Co., Frank W. Lovett; Lock Joint Pipe Co., F. F. Longley; National Water Main Cleaning Co., Clinton Inglee; The Permutit Co., Daniel J. Saunders; Pittsburgh Equitable Meter Co., W. F. Rockwell; Simplex Valve & Meter Co., Everett M. Jones; Wallace & Tiernan Co., Inc., William J. Orchard.

The board has elected William C. Sherwood, secretary of Hershey Manufacturing Co., as president, and Albert E. Paxton, publisher of *Engineering News-Record*, as vice president.

Mayor William Slothower, Dixon, was named president of the Illinois Municipal League to succeed Edmund Thiele, mayor, Hillside. Other officers are: Edward J. Schneidman, Quincy mayor, vice president; Harry B. Luers, Springfield commissioner, treasurer; William H. Winterhoff, supervisor of Thornton Township, Cook County, sergeant at arms; and A. L. Sargent, Springfield, re-named executive director.

The Texas section of the American Society of Civil Engineers has elected the following officers: H. F. R. Helland, San Antonio consulting engineer, president, succeeding George Gill, Dallas; Uel Stephens, Fort Worth, and T. C. Forrest, Jr., Dallas, vice-presidents; and John A. Focht, University of Texas highway engineering professor, of Austin, secretary-treasurer.

J. M. Lang, president of the Ontario Association of Professional Engineers, and P. E. Poitras, president of the Corporation of Professional Engineers of Quebec, have exchanged visits to the quarterly council meetings of their two organizations.

LE ROI Portable Air Compressors
helped speed completion of A-bomb project

Contractor McKee's work on A-bomb project praised at "E" ceremony

Maj. Gen. Leslie R. Groves when he made the presentation said, "The result, as you all know, was a rush construction job, without time for orderly planning and normally without proper time even for the actual construction. But you did your work on time and uncomplainingly. You were never disturbed, as far as I could tell, by the sudden but necessary switches in plans or the demands for speed which must have seemed most unreasonable. You recognized that we were trying to achieve a goal even if you did not know its full importance."

With hours and manpower at a premium, Robert E. McKee, El Paso general contractor, won a dramatic race against time.

His equipment for completing this mammoth task at Los Alamos included Le Roi Portable Air Compressors. In addition to Le Roi units used by Mr. McKee, the E. F. Olds Plumbing & Heating Co., who put in the sewer system, and the Reynolds Electrical & Engineering Co., who installed the power line, both used Le Roi Compressors to speed their end of the job.

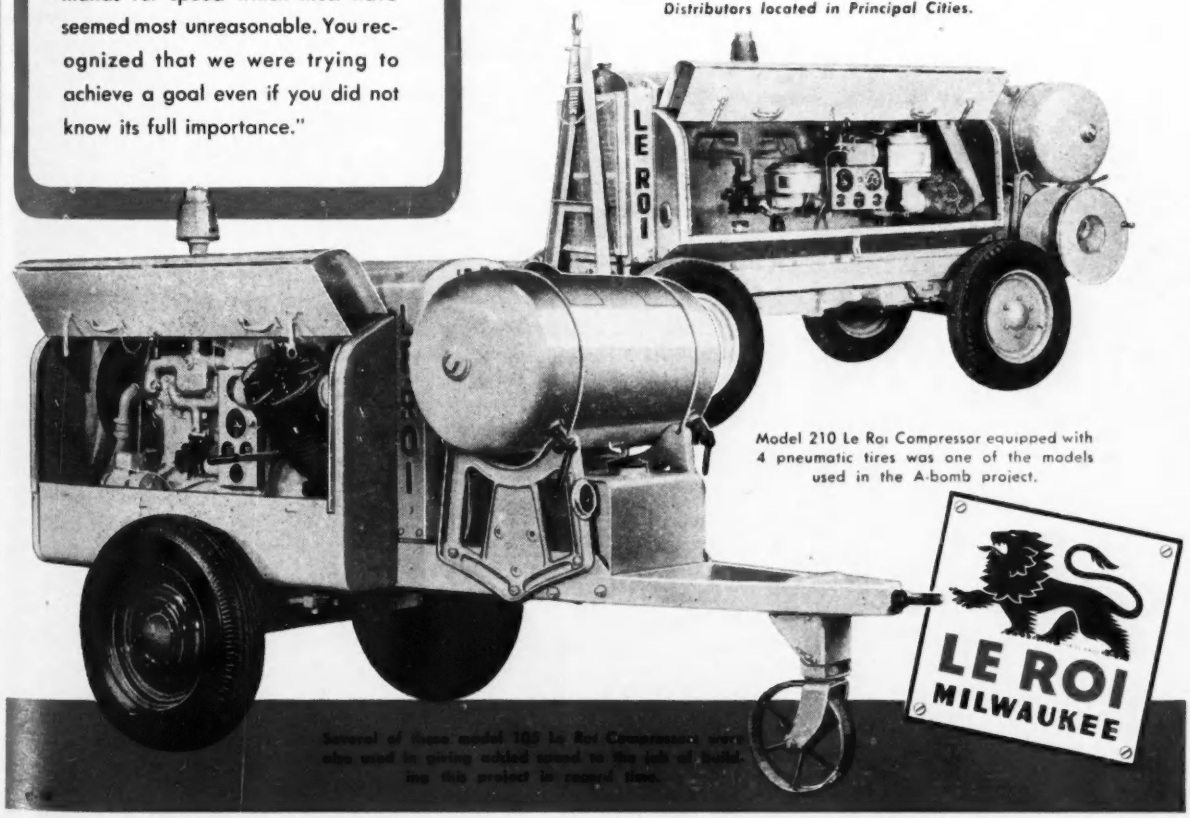
This is a splendid example of the determined, persevering, and unbeatable American spirit which can be satisfied only by achieving today what yesterday seemed impossible . . . and it is tribute to the ability of Le Roi Portable Air Compressors to perform dependably under the toughest operating conditions.

If this type of service is what you need in an air compressor, see your nearby Le Roi distributor or write direct for bulletins.

Le Roi Company

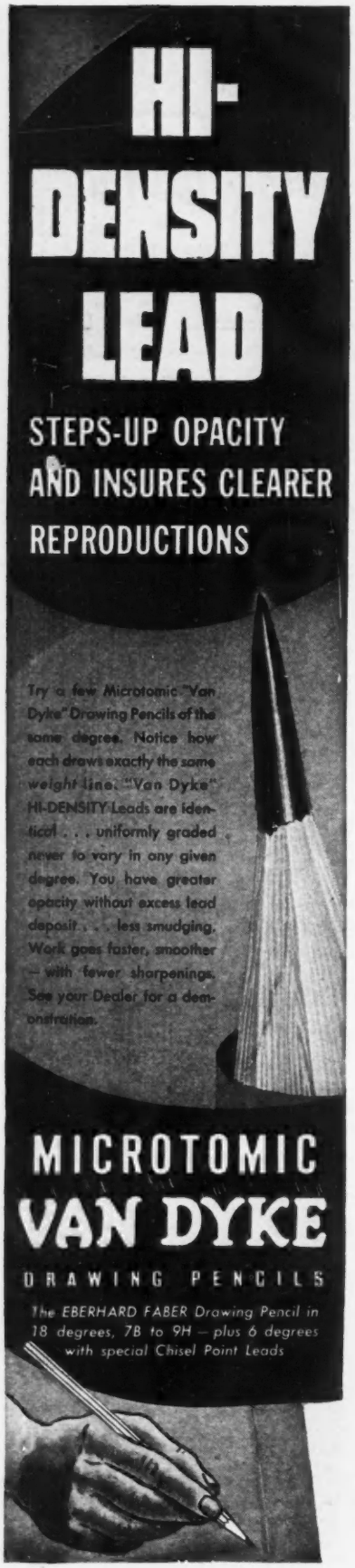
1710 S. 68th Street • Milwaukee 14, Wisconsin

Distributors located in Principal Cities.



Model 210 Le Roi Compressor equipped with 4 pneumatic tires was one of the models used in the A-bomb project.

Several of these model 185 Le Roi Compressors were also used in giving added speed to the job of building this project in record time.


HI-DENSITY LEAD
STEPS-UP OPACITY AND INSURES CLEARER REPRODUCTIONS
Try a few Microtomic "Van Dyke" Drawing Pencils of the same degree. Notice how each draws exactly the same weight line. "Van Dyke" HI-DENSITY Leads are identical . . . uniformly graded never to vary in any given degree. You have greater opacity without excess lead deposit . . . less smudging. Work goes faster, smoother — with fewer sharpenings. See your Dealer for a demonstration.
MICROTOMIC
VAN DYKE
DRAWING PENCILS
The EBERHARD FABER Drawing Pencil in 18 degrees, 7B to 9H — plus 6 degrees with special Chisel Point Leads

Manufacturers' Activities

FLOYD JONES, known in the construction business in America and abroad, has become associated with the Davey Compressor Co., Kent, Ohio, as eastern sales manager in New York City, his territory including the metropolitan area and the New England states.

Jones has been associated with the Ledgerwood Manufacturing Co. and The Union Iron Works, Elizabeth, N. J. He is an authority on hoists, cranes, pile hammers and other construction equipment.

APPOINTMENT of Frank Kennard as sales manager of the new crushed stone division of the Carney Co. Mankato, Minn., has been announced by N. A. Holmer, general sales manager of the Carney Industries. Mr. Kennard was formerly secretary-treasurer of the Kennard Glass and Paint Co., joining the cement division of Carney in 1935. During the war he was with the Allison division of General Motors attached to the U. S. Air Corps as technical representative.

The Carney Co. is installing a new crushing plant at its Mankato quarries. Agricultural limestone, road and airport aggregate and asphalt filler will be produced. The company has also announced the introduction of a new plaster binder batt to be marketed through lumber dealers.

THE WOOD SHOVEL & TOOL CO., Piqua, Ohio, has announced the appointment of V. G. Scott as manager of sales, succeeding the late N. T. Jacobs. Previously Mr. Scott was production manager, having been appointed in December, 1944. He joined the Wood organization in January, 1942, as assistant manager of sales.

Mr. Scott's entire business life has been devoted to the shovel industry. Before joining Wood, he spent ten years with Ames Baldwin Wyoming, in the sales department. Previously he had been connected with the Pittsburgh Shovel Co., in sales work.

THE APPOINTMENT of Hanford Z. Hight as sales manager of Dresser Manufacturing Division, Bradford, Pa., has been announced by Hector P. Boncher, general manager.

For the past three years Mr. Hight has served with the United States Navy as an Air Combat Intelligence officer. His last duty was aboard the escort carrier, U.S.S. Shipley Bay, attached to the Third and Fifth fleets during the Okinawa operation.

Prior to his service with the armed forces, Mr. Hight was district manager of Dresser Manufacturing Division in the mid-west territory.

FIRMAN G. HOYT, salesman for the last six years at the Los Angeles branch of John A. Roebling's Sons Co., has been promoted to the position of product sales manager of the woven wire fabrics division of the company at Trenton, N. J.

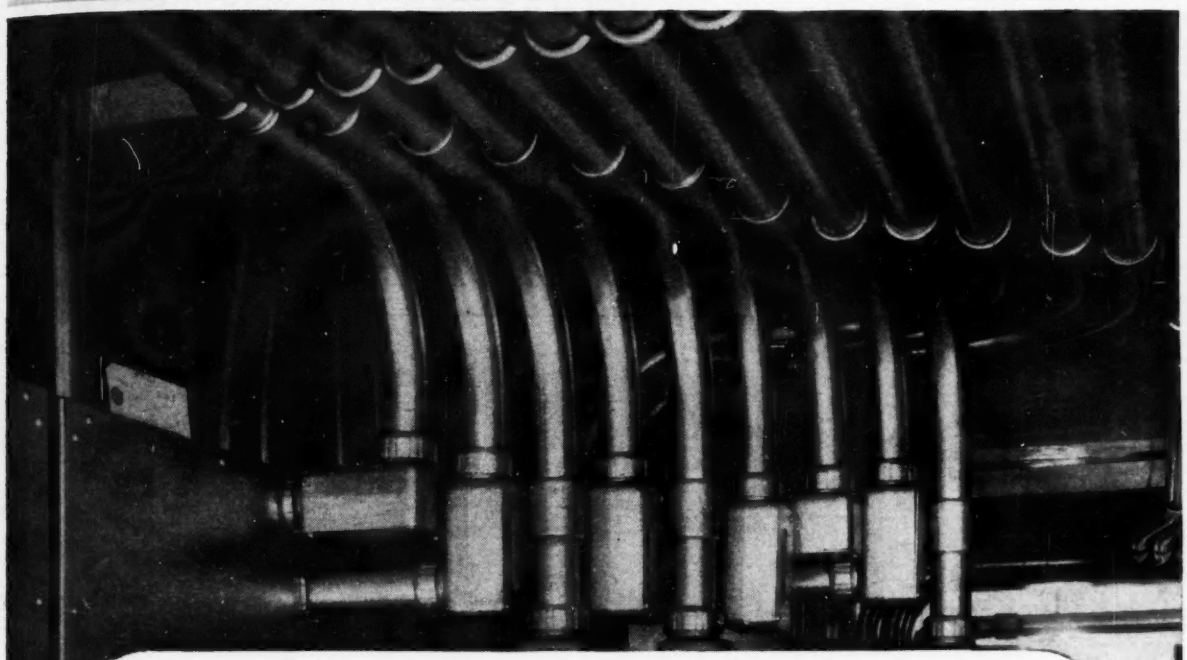
Mr. Hoyt succeeds W. K. Paff, retiring after fifty years service with the company.

THE HOMELITE CORP., Port Chester, N. Y., has opened a new branch office in Seattle, Wash., with A.D. Sherwood in charge. The company makes portable pumps, generators and blowers.

STERLING MACHINERY CORP., Kansas City, Mo., has announced the return of Ernest F. Schreiber from the U. S. Navy. Prior to his war service Mr. Schreiber was director of priority and purchases. He is now assuming the duties of director of purchases.

PLANS FOR INCREASED sales in the Far East were disclosed by Allis Chalmers Manufacturing Co., Milwaukee, Wis., recently with the appointment of

FOR SAFETY'S SAKE . . . USE CONDUIT *(Full Weight Rigid Steel)*



Smart Long-term Planning Demands SAFE Wiring Methods

A double responsibility confronts the electrical industry:

1. The obligation to replace temporary, unsafe wiring systems, installed according to "must do" emergency ideas, forced on industry by shortages and regulations.
2. The duty to install only assuredly safe wiring systems in all new construction.

Remember this: The only wiring system approved by the National Electrical Code as moisture, vapor, dust and explosion proof in hazardous locations is a standard-threaded rigid conduit.

With standard-threaded rigid steel conduit, such as Youngstown's Buckeye, again available through distributors, there is no reason not to provide dependable wiring protection.

Wherever there is moisture, or vapor, or excessive vibration, or possibility of corrosion, or accumulating dust and dirt, or danger of crushing or other mechanical injury, specify and use Youngstown Buckeye Conduit.

YOUNGSTOWN
THE YOUNGSTOWN SHEET AND TUBE COMPANY
YOUNGSTOWN, OHIO
Manufacturers of
CARBON · ALLOY AND YOLOY STEELS

Ask your distributor for
Youngstown Buckeye Conduit · Pipe and Tubular Products · Sheets · Plates · Electrolytic Tin Plate · Coke Tin Plate · Bars · Rods · Wire · Nails · Tie Plates and Spikes

HIGHWAY TRANSPORT . . . VITAL TO VICTORY AND THE AMERICAN WAY OF LIFE

Veteran
# of a Thousand Missions

GMC Truck & Coach salutes the truck drivers of America! During one of the most crucial periods in the history of our nation they have driven nearly 200 billion miles and have transported twice the tonnage of prewar years.

Despite the time of day or night, they kept their dates with rail lines and airlines, war-busy factories and waiting convoys. Regardless of weather or road conditions, they rushed delivery of war materials needed by our Fighters.

To them, and to the men who helped to maintain their vital vehicles, must also go the credit for keeping most of the nation's 4½ million prewar motor trucks on the job, day in and day out, until final victory was won.

NEW GMCs . . . ½ TO 20 TONS . . . NOW AVAILABLE

GMC, builder of nearly 600,000 military vehicles, has now turned its full production facilities to the manufacture of commercial vehicles. Civilian GMC trucks are powered by engines of the same basic design as the famous "270" used in the GMC "six-by-six" . . . the "Workhorse of the Army."

INVEST IN VICTORY . . . BUY VICTORY BONDS

GMC TRUCK & COACH DIVISION
General Motors Corporation
Pontiac, Michigan

HOME OF COMMERCIAL GMC TRUCKS AND GM COACHES . . .
VOLUME PRODUCER OF GMC ARMY TRUCKS AND AMPHIBIAN "DUCKS"

M. M. Tulloch as a sales and consulting engineer in the Dutch East Indies, Malayan states, Burma and Thailand. Tulloch, a dealer in industrial products for that area before the war, will open his office in Singapore next spring, according to Paul Dietz, export sales manager for the firm's general machinery division.

COL. WILLARD F. ROCKWELL, chairman of the boards of Timken Detroit Axle, Standard Steel Springs, Hupp Motor and Pittsburgh Equitable Meter Co., has been elected a director of the LeRoi Co., Milwaukee, Wis.

APPOINTMENT of G. V. Woody to succeed R. C. Newhouse as manager of the Allis-Chalmers basic industries department has been announced by W. C. Johnson, vice-president in charge of the general machinery division. Mr. Newhouse, who will be retained as a consulting engineer, retires after more than 40 years as engineer, inventor and designer of some of the largest cement and mining machinery.

G. V. Woody

Mr. Woody has been manager of the Allis-Chalmers district office at Pittsburgh since 1934, although in 1941 and 1942 he served as administrator of the company's priorities management organization in Milwaukee. Joining Allis-Chalmers in 1909 after graduation from Rose Polytechnic, he was engineer-in-charge of the centrifugal pump section from 1912 to 1919. He then operated an Allis-Chalmers agency for a year before returning as manager of the Wilkes-Barre, Pa., office. From 1926 until he was appointed manager of the Allis-Chalmers Pittsburgh office he was successively vice-president and general manager of the American Rheolaveor Corp. and the Koppers Rheolaveor Corp. and then eastern sales manager of the National Transit Pump Co.

Mr. Newhouse became chief engineer of the crushing and cement department in 1924, and was appointed manager and chief engineer of the company's newly formed basic industries department in 1944, after activities of Allis-Chalmers crushing, cement, mining, flour milling and oil extraction, saw and pulp mill sections

R. C. Newhouse

Preformed wire rope

MULTIPLIES MANPOWER 3 WAYS

Men who actually work with wire rope prefer preformed. They give many different reasons for this choice, but the net result is more work per line before replacement.

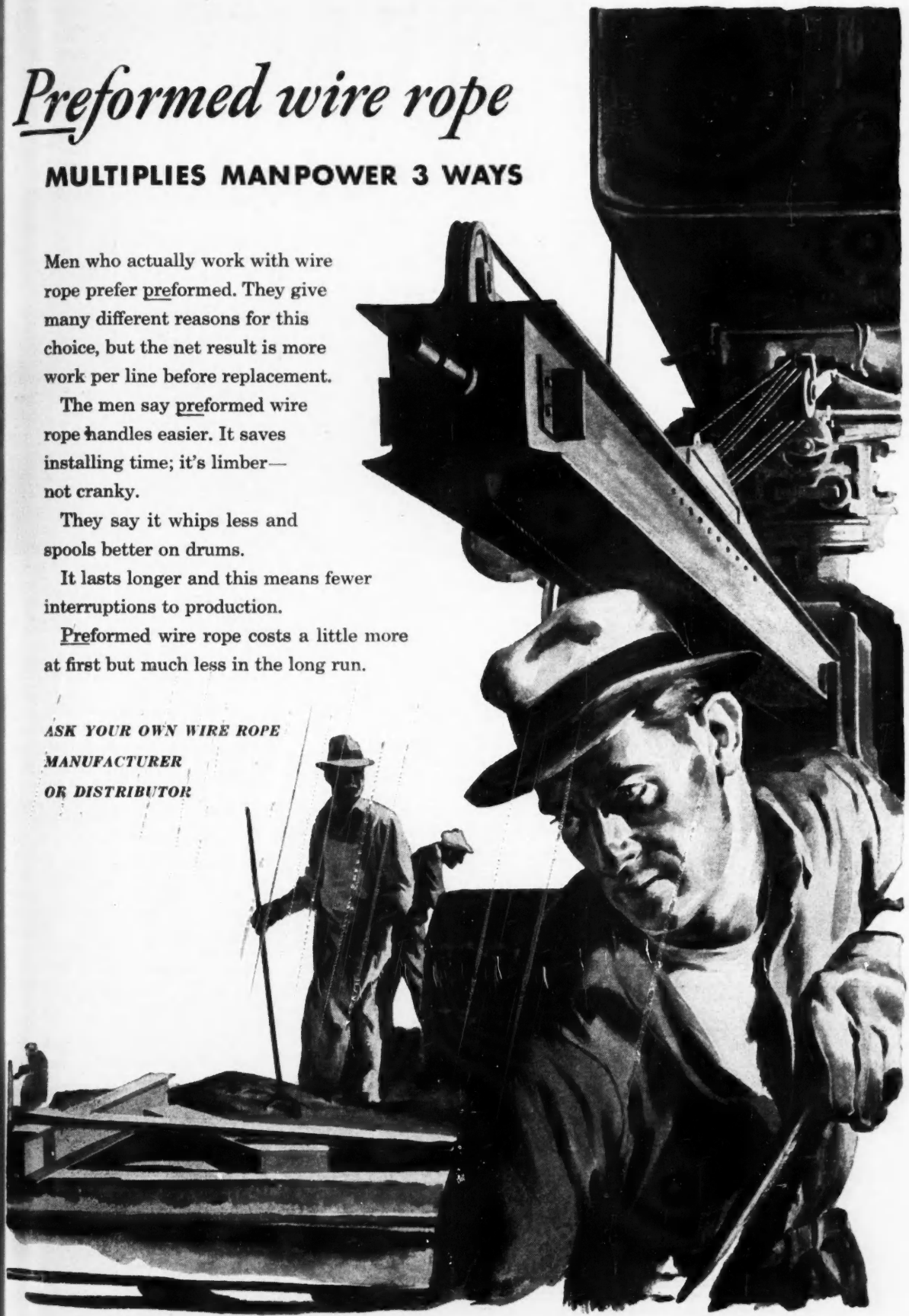
The men say preformed wire rope handles easier. It saves installing time; it's limber—not cranky.

They say it whips less and spools better on drums.

It lasts longer and this means fewer interruptions to production.

Preformed wire rope costs a little more at first but much less in the long run.

ASK YOUR OWN WIRE ROPE MANUFACTURER OR DISTRIBUTOR



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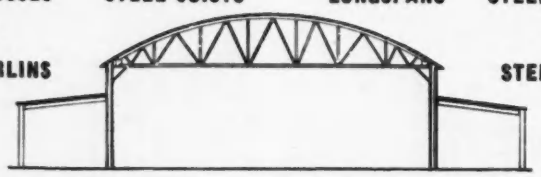
STANDARDIZED SERVICE IN STEEL CONSTRUCTION

ROOF TRUSSES AND ROOF PURLINS | STEEL JOISTS | LONGSPANS | STEEL DECKING AND STEEL SIDING



MACOMBER — Masters of the One Story Steel Building, have a real service for you. It includes:

1—Fabrication and erection of the complete building.

2—Fabrication of the roof supporting members only where masonry walls are used.

3—A wealth of engineering information as a result of specialization in this type of construction.

Here is standardization in steel building products that does not limit either you nor the occupant in the kind of building that serves his needs best. Your contractor knows Macomber products. He will expend far less equipment in their erection. If you are interested in some helpful suggestions and further information drop us a line.

MACOMBER

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MEMBER OF THE STEEL JOIST INSTITUTE

Simplex Automatic Lowering Jacks are faster and safer. 5 to 35 tons.

Simplex LEVER · SCREW · HYDRAULIC Jacks

for every construction purpose

Awarded the Gold Medal for Safety

Ask for Catalog 44

Templeton, Kenly & Co., Chicago 44, Ill.

DRILLING ANYWHERE

We look into the earth

PENNSYLVANIA DRILLING COMPANY

PITTSBURGH, PA.

were brought together.

An employe of Allis-Chalmers since 1905, Mr. Newhouse specialized in crushing and mining engineering, designing many types of crushers, mills, kilns, coolers and dryers.

UNDER A NEW PLAN of the Cummins Engine Co., Inc., sales activities will be divided into two major fields—direct sales through dealers, and sales to manufacturers who power their equipment with diesels.

N. E. Palmer

In the reorganization, Normal E. Palmer becomes general sales manager to work with Vice-president P. E. Letsinger. J. D. Allen becomes sales manager of dealer organizations, and Fred W. Sparks becomes sales manager of manufacturing accounts. Mr. Palmer for the past three years has been the Washington, D. C. representative for Cummins, and in that post was responsible for delivery of thousands of diesel engines to the government, and to equipment manufacturers fulfilling government contracts for a wide variety of military and highly essential applications.

Prior to becoming Washington representative, Mr. Palmer, a graduate engineer from Purdue University, had been a member of the New York regional office sales staff.

Mr. Allen will supervise the activities of the 126 Cummins dealers in the United States and Canada. Beginning with the Cummins company in 1938, and serving in various departments which gave him a thorough knowledge of diesel engines, Mr. Allen for the past year and a half has been assistant sales manager.

J. D. Allen

Mr. Sparks, the sales manager of manufacturing accounts, comes to his new job directly from the position of manager of the Cleveland regional office, a territory which includes a number of manufacturers who offer their heavy-duty equipment powered with Cummins diesels. Prior to that, he

F. W. Sparks

Commissioned

FOR ALL FRONT-LINE SERVICE

THE General
TYPE 10 - MODEL 105

•

THE ORIGINAL
"MACHINE OF TOMORROW"

ONE MAN
ONE ENGINE
ON RUBBER

General Ironguts is proud to commission this newest General for duty on the construction, excavating and materials handling "fronts." Built by General—the company that pioneered the one-man, one-engine, rubber-tired Supercrane five years ago—this latest General is another "first" that takes its place as a leader in the construction machinery field.

ALL-IN-ONE. The General Type 10, Model 105 is a combination unit that will turn in profits on any job. Shovel, crane, backhoe, dragline, magnet or pile driver . . . you name the job, then watch this amazing machine do the work faster, better and cheaper!

ONE-MAN, ONE-ENGINE. Positive acting, simple controls plus a single heavy-duty engine—that's the reason for the smooth, efficient performance that comes natural to the Type 10. Swing, travel, boom—operated simultaneously or independently—every function is performed with clock-like precision that cuts working time to a minimum!

AND ALL THIS. Fast highway travel (more than 20 mph) with absolute safety, air booster steering, optional four-wheel drive, heavy duty clutches and transmission, 4 speeds forward, 4 speeds reverse, easy, quick changeover of attachments . . . mobility and ease of operation that get the most difficult jobs done in record time! Conforms to all highway regulations and in most states needs no permit to travel over the roads.

WRITE TODAY!

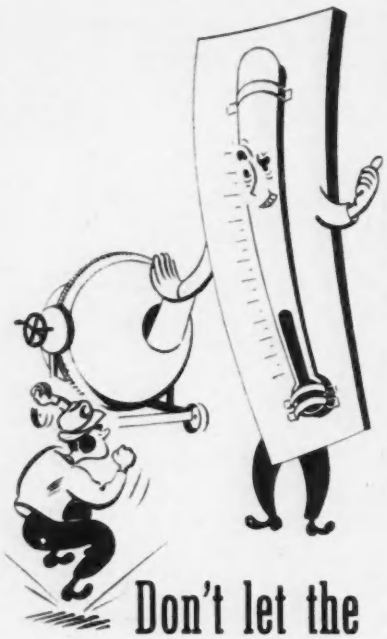
The complete story of this profit-making, versatile rig is of vital interest to every man interested in construction, excavating or materials handling. Ask your nearest distributor for your free copy of the General Type 10, Model 105 specifications, or write **THE GENERAL EXCAVATOR CO., MARION, O.**

Associated with **The Osgood Company**

THE OSGOOD COMPANY
SHOVELS, DRAGLINES
CRANES
CRAWLER & WHEEL MOUNTS
DIESEL, OIL, GAS, ELECTRIC

GENERAL EXCAVATOR CO.
CRANES-SHOVELS GENERAL OSGOOD MARION OHIO U.S.A.
MARION, OHIO

CRANES, DRAGLINES AND SHOVELS



Don't let the thermometer Slow You Up!

Speed Concrete in Freezing Weather with

SOLVAY CALCIUM CHLORIDE

Your concreting operations need not be slowed up by low temperatures — just add SOLVAY Calcium Chloride to your mix.

SOLVAY Calcium Chloride should be added to concrete at all seasons, to increase early and final strengths, provide uniform, dependable curing. During cold weather, Solvay Calcium Chloride gives added cold weather protection and shortens protection period. Substantially lowers all concreting costs, regardless of the seasons.

Send for FREE 48-page booklet, "Calcium Chloride and Concrete." Write to Dept. 37-12

SOLVAY SALES CORPORATION

40 Rector Street, New York 6, N. Y.

was a sales engineer in the home office at Columbus, Ind., and as a result of his duties in that position, became familiar with the problems of virtually every manufacturer of equipment requiring heavy-duty engine installations.

APPOINTMENT of Gordon W. Monfort to the advertising department of Caterpillar Tractor Co., as director of the news bureau, is announced by G. M. Walker, advertising manager. Since early in the war Mr. Monfort had served as personnel director at Caterpillar's San Leandro, Calif., plant.

A native of Colorado, Mr. Monfort was educated at Stanford University. He joined Caterpillar's advertising department in 1928 but when the company offices were moved to Peoria in 1930 he remained in California to engage in business for himself. He performed several special assignments for Caterpillar and in 1937 rejoined the company as western division advertising representative, until 1941 when he became personnel director.

THE APPOINTMENT of Robert M. Darr as advertising manager of Le Roi Co. and Centaur Co. has been announced by John Dolan, manager of the sales division. Mr. Darr joined Le Roi in January, 1941, as an instruction manual copywriter, shortly becoming manager of that department. His work involved extensive research and planning in the publishing of U. S. Army and Navy technical manuals and service parts catalogs.

Darr attended the John Huntington Polytechnic Institute, and later continued his studies of advertising and merchandising at Marquette University. He spent four years with a large tractor manufacturer producing instruction manuals, and gained additional sales and service experience with the L. D. Mather Co.

THREE NEW VICE-PRESIDENTS have been named for the sales organization of International Derrick and Equipment Co., Columbus, Ohio, one of the Dresser Industries. Ferguson Barnes has been promoted to vice-president in charge of sales, having been in engineering and

Streamlined INSIDE for Higher Efficiency and Lower Operating Costs

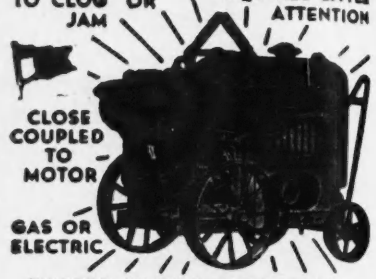
NO ORIFICE OR PRIMING VALVES TO CLOG OR JAM

HOLDS PRIME

REQUIRES LITTLE ATTENTION

CLOSE COUPLED TO MOTOR

GAS OR ELECTRIC



RUGGED SIMPLICITY OF DESIGN ELIMINATES RECIRCULATION—

DELIVERS GREATER VOLUME PER GAL. OF GAS

CAPACITIES UP TO 125,000 GPH

The GORMAN-RUPP CO. Mansfield, Ohio

GORMAN-RUPP

Self Priming Centrifugal Pumps

only 1 Man required to operate

SAUERMAN

Scrapers or Slackline Cableways

SAVE LABOR! CUT COSTS!

Sauerman Crescent scraper bucket shown above digs and hauls at speed of 400 f.p.m.

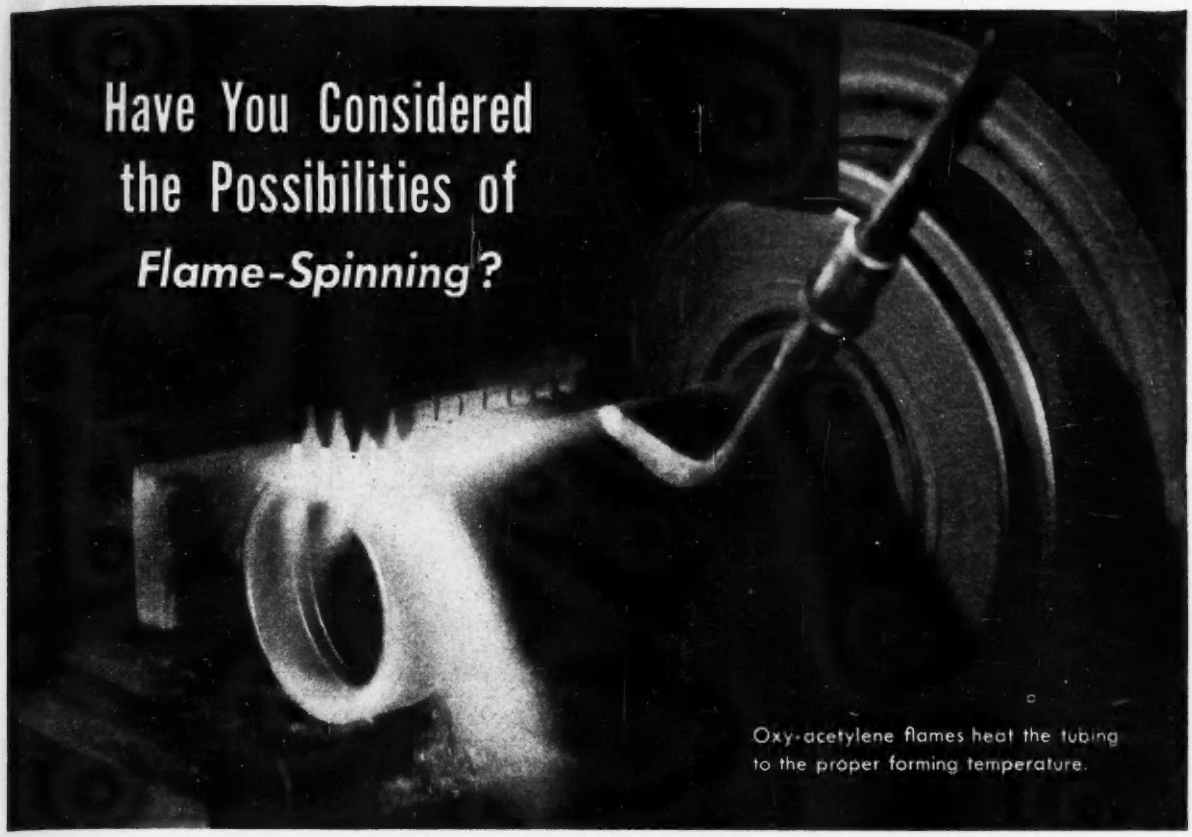
Ranges over a large area. *Economical* for small or large material-handling jobs. Size and type for your needs. ONE-MAN easily operates.

Send for details. Let users tell you about Sauerman efficiency and saving! Ask Sauerman engineers any questions. Wire or write.

SAUERMAN BROS., Inc.

532 S. Clinton St., Chicago 7, Ill.

Have You Considered the Possibilities of *Flame-Spinning?*



Oxy-acetylene flames heat the tubing to the proper forming temperature.

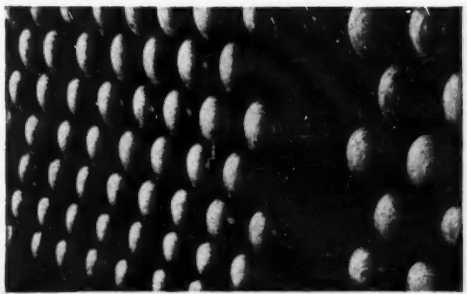
IT is a fast, inexpensive way to form tubular parts. Flame-spinning will partially close the ends of tubing . . . or make complete closures . . . or reduce diameters at any point. There is no limit to the diameter of tubing that may be flame-spun, provided the ratio of tube diameter to wall thickness does not exceed 50 to 1.

In the pictures, tubing 3 inches in diameter, made from 12-gage sheet, is being end-formed for use in chemical converters. It takes only 45 seconds to close each tube completely.

Ask a Linde representative to show you how you can use the flame-spinning process . . . or write for a copy of the folder, "Flame-Spinning Process," Form 5915.

BUY AND HOLD UNITED STATES VICTORY BONDS AND STAMPS

The flames are withdrawn to allow the forming tool to shape the tube end.



The completely closed tubes are ready for installation in chemical converters.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

Construction Machinery Manufacturers:

THE finest machine in operation is no better than the gears that are a part of it. We are aware of the tough service gears must meet in construction machinery. That is why we make them strong and durable. Every "Industrial" gear is accurately machined and cut. All of them are carefully inspected and tested. They are uniformly strong and durable. When you assemble "Industrial" gears in your machines they fit properly. You know they will do the job you expect of them.

Our organization is schooled in prompt, reliable service. We offer you quick quotations on gears exactly to your specifications.

Write us

on your letterhead for Catalog and Handbook

INDUSTRIAL GEAR MFG. CO.

4536 Van Buren St.
Chicago 24, Illinois

Manufacturers of

Fine Cut Gears for Machinery Builders: Spur, Helical, Bevel, Mitre, Worms, Worm Gears, Racks, Silent Chain Wheels and Special Sprockets.

sales in the oil field and construction industries for 30 years. H. L. Putnam joins the firm as vice-president to supervise all direct sales in the mid-continent and Rocky Mountain region, including both equipment and supply store sales. G. W. Walton, formerly manager of Ideco drilling machinery sales, has been elected vice-president of machinery sales, continuing his previous duties. Mr. Barnes will make his headquarters in Columbus, while Mr. Putnam and Mr. Walton will be in Dallas, Tex.

W. J. HAZELTINE, formerly vice-president in charge of distribution, has been named general sales manager of The Buffalo-Springfield Roller Co., Springfield, Ohio. In the civil engineering and construction fields since 1913, Mr. Hazeltine's is well known in the construction industry.

Following his graduation as a civil engineer from Ohio Northern, Mr. Hazeltine was city engineer of Mansfield, Ohio, from 1913 to 1917. Prior to World War I, he assisted in the supervision of the construction of Camp Meade, and immediately following his enlistment in the Navy he was assigned to the construction of the Great Lakes Naval Training Station.

After his release from the service in February, 1922, Mr. Hazeltine joined The Buffalo-Springfield Roller Co. as a sales representative, starting with the northern Ohio territory and later extending his field to the entire country. More recently, he has been responsible for the establishment of a Buffalo-Springfield distributor's organization for the United States. Mr. Hazeltine is a member of the Advisory Committee of the Construction Machinery Branch of the O.P.A.

J. H. HEINTZ, sales and construction engineer identified with the construction industry for the last 25 years, has been appointed general sales manager of the C. S. Johnson Co., manufacturers of construction machinery and equipment at Champaign, Ill. He was engaged in airport construction in Florida and Central America from 1941 to 1944. Previously for 12 years he had operated his own construction materials and steel jobbing business, later going into the engineering and general contracting field.

A veteran of World War I, early in his career Mr. Heintz was associated with the Missouri State Highway Department on location, plans and surveys. Later he was a construction engineer with the Morgan Engineering Co. of Memphis, Tenn. Prior to entering into business for himself in 1929, Mr. Heintz was sales engineer and western district sales manager of the structural products department of the Wickwire-Spencer Steel Co. at Chicago. The C. S. Johnson Co. manufactures ready-mixed concrete plants and machinery and material handling equipment.

KENWORTH MOTOR Truck Corp., Seattle, Wash., has purchased the Fisher Body plant there from General Motors Corp. to consolidate Kenworth's truck and bus business with similar business of its parent company, Pacific Car & Foundry Co.

GENERAL MOTORS Fleet Division has reopened Seattle, Wash., offices with D. R. Paul as manager for Washington, Oregon, Idaho and Washington. Paul formerly was at Washington, D. C., in charge of national field relations for a governmental emergency agency.

SHEFFIELD STEEL CORP., Kansas City, Mo., has announced the appointment of Alfred B. Egan as manager of sales, reinforcing products division.

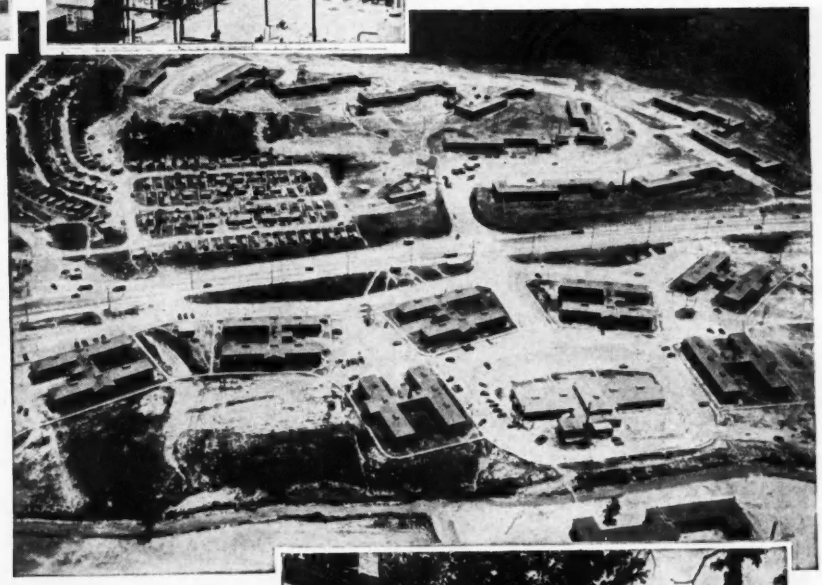
Mr. Egan has been with Sheffield for sixteen years, for the greater part of that time in charge of the Des Moines office.

From 1942 until March, 1945, he was in charge of Sheffield's Washington, D. C., office. Last March he was appointed district manager, Chicago district. Sales of Sheffield Steel products for the building and construction field will be under his spervision.

ELMER C. WELDEN has been appointed engineering director of the Association of Metal Culvert Manufacturers in New England, comprising Bancroft and Martin Rolling Mills Co., Portland, Me., Berger Metal Culvert Co., Somerville, Mass.; and New England Metal Culvert Co., Boston, Mass. Mr. Welden spent three years in Mexico in engineering work. Later he served the Connecticut State Highway Department as division engineer, for 18 years as deputy commissioner. One of the notable projects completed dur-

CLAY PIPE LICKS ACIDS-GASES IN ATOMIC BOMB PRODUCTION

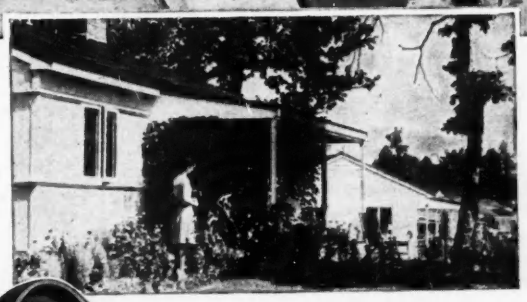
Clay Pipe was a necessity in building fume-carrying air ducts and waste disposal lines for the atomic bomb factories, where no details could be left to chance. Clay Pipe could be depended upon to carry acids, gases and alkalies year after year without decomposition.



Because it is made of clay, which is chemically inert to begin with . . . then is fired to a hard, tough texture by a process called vitrification . . . Clay Pipe is not affected by acids, gases, chemicals and all kinds of industrial wastes. Clay Pipe handles whatever waste comes its way.

•

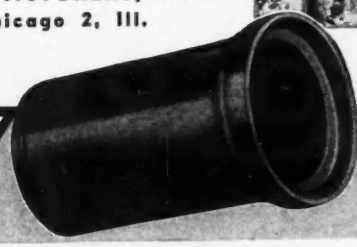
By providing the drains and sanitary sewers, Clay Pipe speeded the conversion of 10,000 acres of farm and woodland to the fifth largest city in Tennessee in less than two years. Clay Pipe, wall coping and chimney flues contributed to a housing achievement almost as colossal as the atomic bomb itself.



The future of atomic power is at present a matter for speculation. But there is no speculation about the advantages of Clay Pipe in well-planned construction projects, both large and small. Clay Pipe is no new idea. It will serve well in the future for the same reason it serves well today and has served well in the past. Because it never wears out!

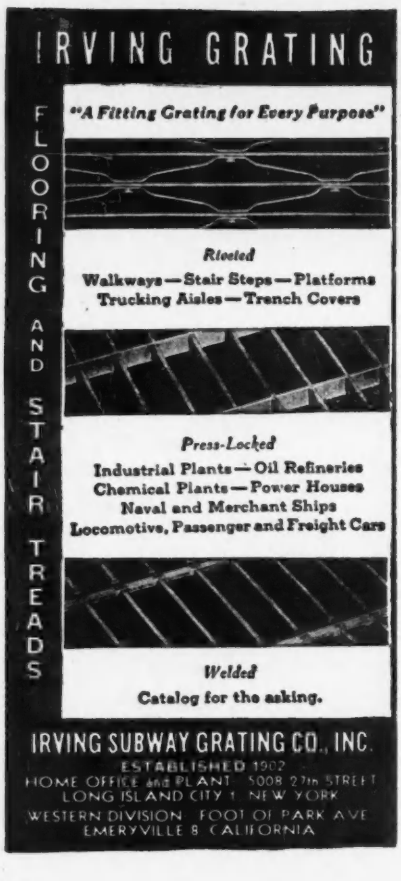
C-1045-10

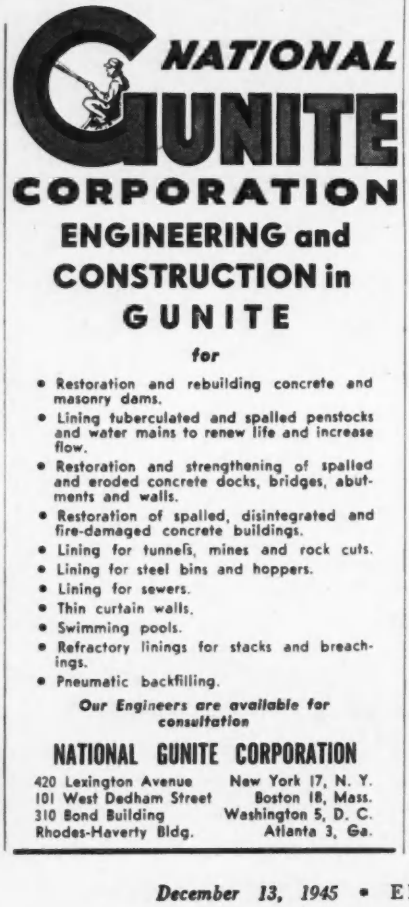
NATIONAL CLAY PIPE MANUFACTURERS, INC.
111 W. Washington St., Chicago 2, Ill.



CLAY PIPE

SPEED
CONSTRUCTION
WITH
CLIPPER
MASONRY SAWS
Cut the desired shape or size at a moment's notice, from
GLAZED TILE . . .
BRICK . . . . .
CONCRETE BLOCKS
. . . . or any other Masonry Material, regardless of hardness or density.
Offered to You on
FREE TRIAL
CLIPPER PORTABLE HOISTS
by the Makers of
CLIPPER MASONRY SAWS
CLIPPER MFG. CO.
4016 MANCHESTER • ST. LOUIS 10, MISSOURI
Factory Branches
Philadelphia Kansas City Austin, Texas




NATIONAL
GUNITE
CORPORATION
ENGINEERING and
CONSTRUCTION in
GUNITE
for
• Restoration and rebuilding concrete and masonry dams.
• Lining tuberculated and spalled penstocks and water mains to renew life and increase flow.
• Restoration and strengthening of spalled and eroded concrete docks, bridges, abutments and walls.
• Restoration of spalled, disintegrated and fire-damaged concrete buildings.
• Lining for tunnels, mines and rock cuts.
• Lining for steel bins and hoppers.
• Lining for sewers.
• Thin curtain walls.
• Swimming pools.
• Refractory linings for stacks and breachings.
• Pneumatic backfilling.
Our Engineers are available for consultation
NATIONAL GUNITE CORPORATION
420 Lexington Avenue New York 17, N. Y.
101 West Dedham Street Boston 18, Mass.
310 Bond Building Washington 5, D. C.
Rhodes-Haverty Bldg. Atlanta 3, Ga.

ing Mr. Welden's service as dep commissioner was the Merritt Parkw Other important projects were t Hartford-East Hartford Bridge and t New London-Groton Bridge.

RETIREMENT of David S. Gende Jr., general manager of erection, Be lehem Steel Co., after 45 years of service, has been announced by E. J. Paulus, general manager of the fabricated steel construction division. Mr. Gendell is succeeded by J. H. Wagner, manager of erection in the New York district since 1928. C C. Lane succeeds Mr. Wagner.

Mr. Gendall has had a long and su cessful career in steel construction during which 3,150,000 tons of fabr cated steel were erected under hi supervision. Upon graduation from th University of Pennsylvania in 1899 a a civil engineer he was employed b Shiffler Bridge Co., later purchased b American Bridge Co. In May, 1901, h entered the employ of McClintic-Mar shall Construction Co. as a designing engineer and remained with that or ganization after it was acquired b Bethlehem Steel in 1931.

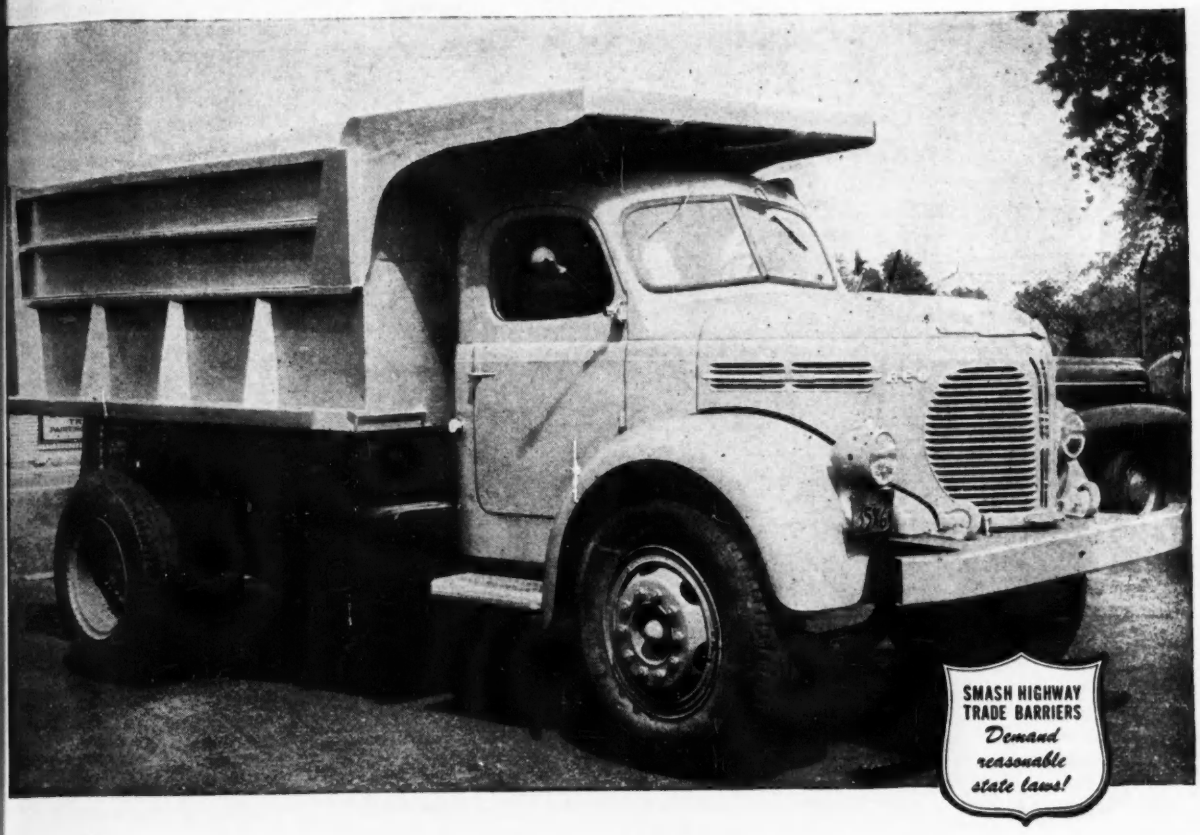
Mr. Gendell supervised the erection of steel work for the Golden Gat Bridge at San Francisco and also mos of the steel work of the Pulaski Skyway between Newark and Jersey City, N. J Recently he supervised the erection o steel for buildings at Oak Ridge, Ky the atomic bomb city, for the Man hattan Engineering Project.

ELECTION of Robert B. McColl as ex ecutive vice-president of American Lo comotive Co., has been announced by Duncan W. Fraser, president. Mr. McColl is succeeded as vice-president in charge of manufacturing by W. L. Lentz of Schenectady, N. Y., who directed the company's tank and locomotive manufacturing program there during the last five years.

R. B. McColl

Mr. McColl has been engaged in locomotive manufacture since boyhood when he started as an apprentice with the Glasgow and Southwestern Railroad in Scotland. After a period with the original builder of the steam locomotive, Robert Stephenson and Sons in Darlington, England, he went with the

Reo looks TOUGH *and is!*



Reo is all truck, from the powerful precision-built engine to the massive, cold-riveted frame structure and sturdy rear axle. It not only looks TOUGH, but it is tough!

Reo has long been a favorite in the building and construction field because of its dependable operation and long life in the toughest service. It has proved it is built for the heavy loads, the rutted roads and the long hard pulls.

Today's Reos are the finest in Reo's long history. They are now being delivered as fast as possible through a nation-wide sales and service organization of factory-controlled branches, distributors and dealers. Ask your Reo dealer for complete specifications.

REO MOTORS, INC., LANSING 20, MICHIGAN

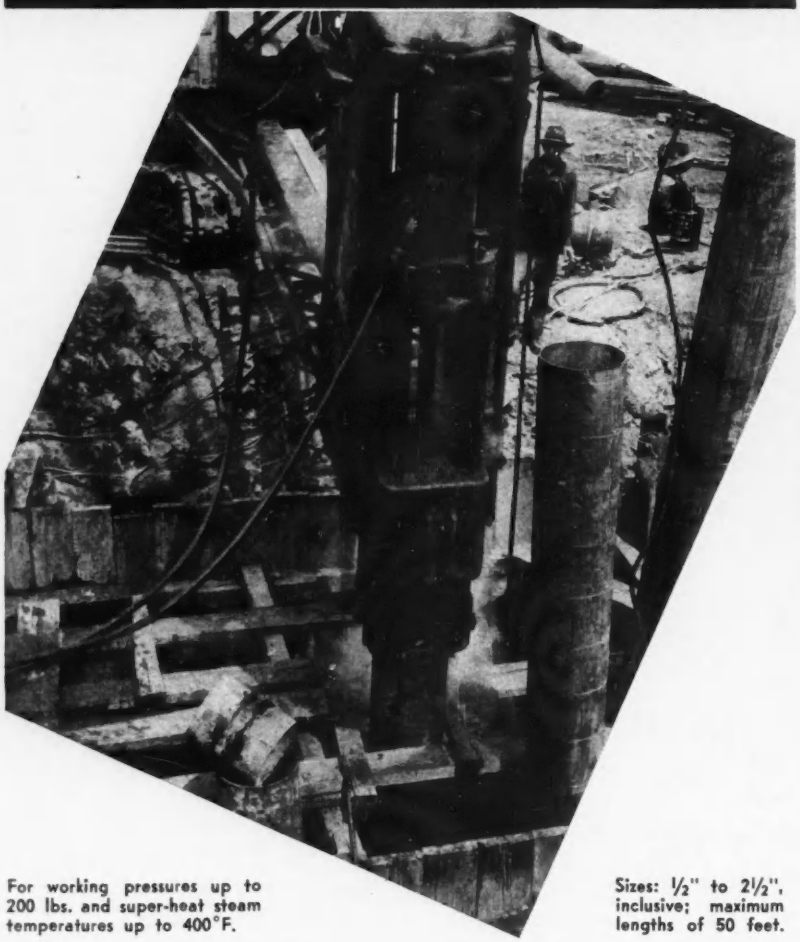
Factory Branches, Distributors and Dealers in Principal Cities

BUY U. S. BONDS

REO

1904 • AMERICA'S TOUGHEST TRUCK • 1945

"INFERNO"... the Steam Hose With *Greater Driving Power*



For working pressures up to 200 lbs. and super-heat steam temperatures up to 400°F.

Sizes: ½" to 2½", inclusive; maximum lengths of 50 feet.

A Goodall "Standard of Quality" product, with many years of service to prove its unequalled reliability and safety. Carcass is made of high-tensile asbestos mandrel cured. Tube provides highest resistance to excessive temperatures. Special construction retards escape of steam should hose become punctured. Will withstand continuous flexing.

Contact our nearest branch or main office for details of this and other products by GOODALL . . . "On the Job LONGER!"

GOODALL RUBBER COMPANY, INCORPORATED

WE ARE PARTICIPANTS IN THE OWNERSHIP AND OPERATION OF NATIONAL SYNTHETIC RUBBER CORPORATION

GOODALL-RUBBER CO. INC. R G G

THE GOODALL-WHITEHEAD COMPANIES

Philadelphia • Trenton • New York • Chicago • Pittsburgh • Boston
Los Angeles • San Francisco • Seattle • Salt Lake City • Houston

Factory—Trenton, N. J. Established 1870

Montreal Locomotive Works in Canada, an affiliate of American Locomotive Co. After World War I he was with the Armstrong Whitworth Co. in England but soon returned to the American Locomotive Co. as assistant manager of the Schenectady works.

He has been successively manager of that plant and president of the company's diesel engine manufacturing division, president of the Alco Products division of the company, and vice-president in charge of manufacturing for the locomotive company. During the war period, he directed the company's war production program. Mr. McColl was educated at Kilmarnock Academy and the Science and Art College, in his native Kilmarnock, Scotland.

W. L. Lentz

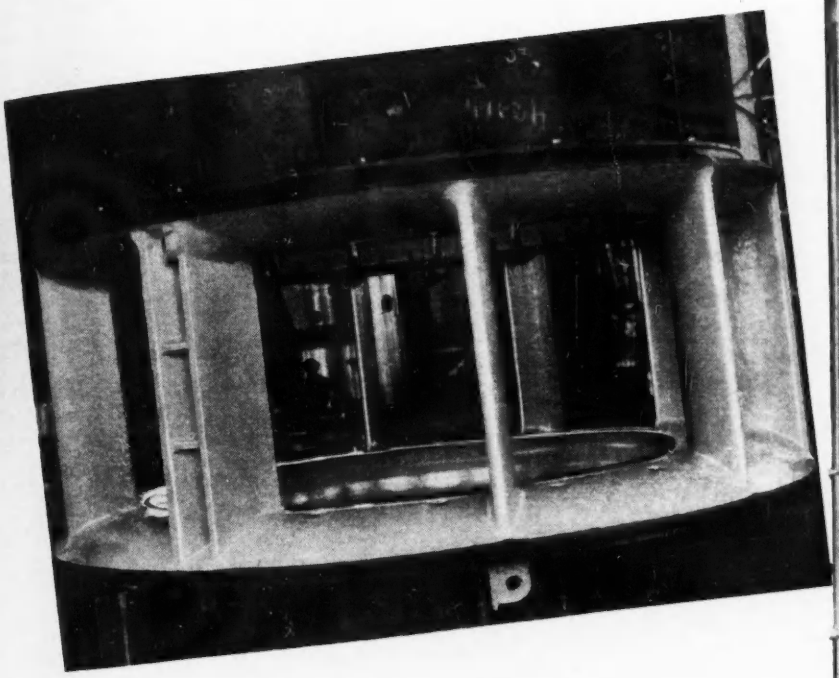
Mr. Lentz, formerly with the New York Central System, took over the management of the Schenectady plant at the outset of the war and supervised its conversion to what was at one time the country's second largest tank producing arsenal. This plant likewise built all of the tank killers used by Montgomery in routing Rommel at El Alamein.

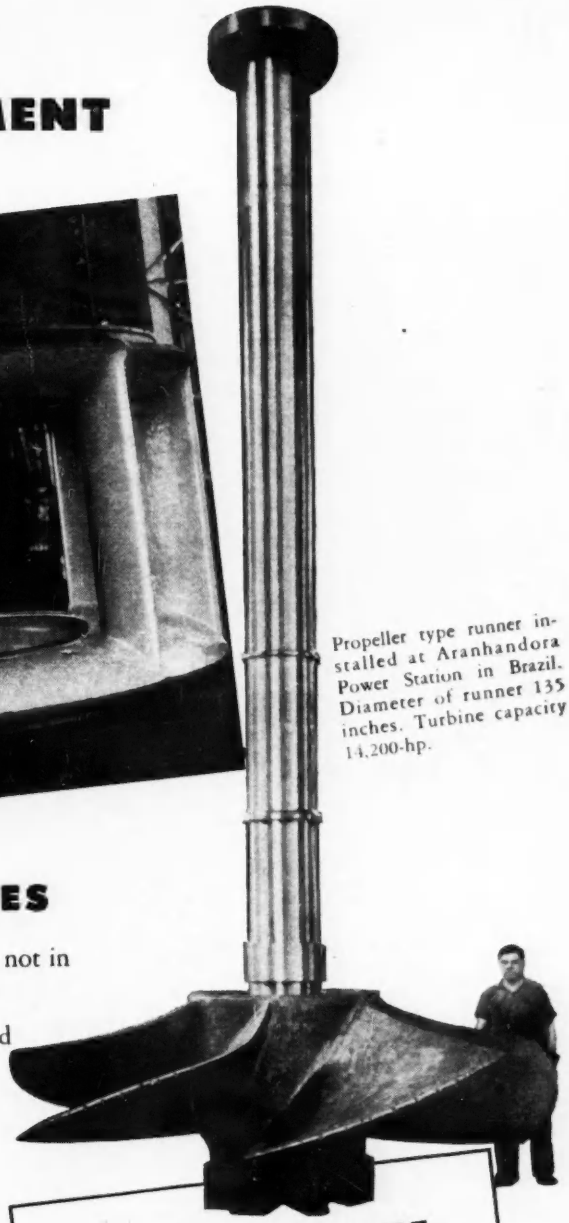
An aviation cadet and artillery officer in the last war, Mr. Lentz began railroading in 1913 with the New York Central. For an interval after 1937 he was sales manager of the Standard Stoker Co.

APPOINTMENT of Burnell O. Burritt to the engineering staff of Craftsman Tool and Die Co., Detroit, Mich., has been announced by Carl Swartz, general manager. Formerly, Burritt was associated with Federal Machine and Welder Co. as hydraulic development engineer; with Marquette Metal Products Co., Cleveland, Ohio, as chief engineer for four years; and with Woodward Governor Co., Rockford, Ill., as experimental engineer. As hydraulic design engineer, he will be in charge of the development of Craftsman's new lines of hydraulically-operated production equipment.

ROBERT NEREM has succeeded J. A. Parks, retired, as superintendent of Standard Oil Co. of Indiana's sales department for construction engineering.

For economical
LOW HEAD DEVELOPMENT





Propeller type runner installed at Aranhandora Power Station in Brazil. Diameter of runner 135 inches. Turbine capacity 14,200-hp.

PROPELLER TYPE TURBINES

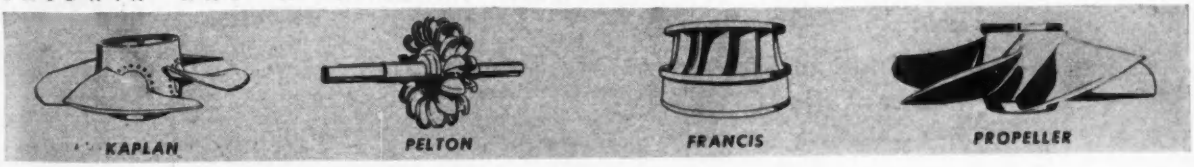
Propeller type turbines are indicated for heads not in excess of 100 feet and in cases where water economy, at heads considerably lower than the rated output, is not of primary importance. The selection of the proper turbine, to suit the conditions of any particular installation, is essential for economical development of water power. Baldwin engineers have been solving problems of this kind for many years. Perhaps they can assist you.

BALDWIN
HYDRAULIC TURBINES

THE BALDWIN LOCOMOTIVE WORKS • PHILADELPHIA, PA., U. S. A.

I. P. MORRIS DEPARTMENT, EDDYSTONE, PA. • THE PELTON WATER WHEEL CO., SAN FRANCISCO, CALIF.

BALDWIN HAS A TURBINE FOR EVERY TYPE OF INSTALLATION



DON'T BE A WOODPECKER

WITH

WARRINGTON-VULCAN

Single-Acting Steam

PILE HAMMERS

This rugged pile driver doesn't peck at piles—it rams 'em home with low velocity blows from a relatively heavy ram, delivering proved performance with speed and economy. It gets results through rapid, regular and continuous action, operating at a medium steam pressure. All working parts are exposed for easy accessibility. Sturdy construction and simple design give you easy operation, save you maintenance and mechanical costs. The Single-Acting Warrington - Vulcan drives any kind of pile—wood, steel or concrete, and it's been proved on the tough jobs since 1887.

We'll gladly furnish full details. Write today.

VULCAN IRON WORKS
Since 1852
331 North Bell Avenue
Chicago 12 ... Illinois

Mr. Parks retired recently after nearly 28 years' service. Mr. Nerem joined the company in 1926 as a draftsman and became assistant superintendent in 1936. He is a graduate in civil and structural engineering from the Norwegian Institute of Technology. His place as assistant superintendent will be filled by transfer of R. A. Niles from South Bend, Ind. Mr. Niles has been superintendent of construction for several years, and he served also at Green Bay, Wis., from 1937 to 1940.

THE HURON PORTLAND CEMENT CO. of Detroit, Mich., has appointed C. L. Laude general sales manager and P. L. Biasell purchasing agent.

JOHN P. CAMM, manager of the Leeds, Ala., plant of Universal-Atlas Cement Co., U. S. Steel subsidiary, has been appointed manager of the plant at Osborn, Ohio, recently acquired from the Wabash Portland Cement Co. Mr. Camm became associated with the company in 1925. W. O. Lawrence, assistant plant manager, has been made acting manager. Mr. Lawrence has been connected with the company since 1933, and has served in various capacities, working out of the New York office as field engineer for two years. Wade W. Postello, auditor, has been transferred to the Independence, Kan., operation in the same capacity. He succeeds Clarence Graves, Jr., resigned.

Manufacturers' Publications

Construction Equipment Safety—A new sound slidefilm on accident prevention in the heavy construction industry has just been completed. It covers the causes and prevention of accidents in the use of such equipment as bulldozers, cranes, tractors, cats, steam shovels, dump trucks, etc. During 1944, 1,800 workers met death by accidents on construction work, the council reports. This death rate is the second highest among the major industrial groups and is nearly four and one-half times greater than the average rate for all industry.

A manual has been prepared as an aid to group discussions on construction accident prevention to follow showings of the film.—*National Safety Council, Inc., 20 North Wacker Drive, Chicago 6, Ill.*

Material Moving—A 12-page booklet describes powerful digging and loading machines designed for multi-purpose utility and built to stand up under the severe service of high speed dirt and material moving. They are said to combine the usefulness of a shovel, loader, scraper, bulldozer, angle grader, and trailbuilder.—*Trackson Co., Milwaukee 1, Wis.*

Building Towers and Elevators—A folder tells all about inexpensive portable, units to hoist materials and supplies on building projects quickly, safely and efficiently. The company has also issued new pieces of literature on hoists, derricks, pile drivers and cranes. —*Clyde Iron Works, Inc., Duluth 1, Minn.*

Underwater Cutting and Welding—A booklet reproduces a chapter on underwater cutting and welding by Charles Kundel, inventor of an arc-oxygen underwater cutting torch. It has to do with the process of cutting metals of any thickness at any depth under water to which divers may descend, using oxy-gas or the electric arc process. Underwater welding refers to the metallic arc process. — *Craftsweld Equipment Corp., 2727 Jackson Ave., Long Island City, N. Y.*

✓ **Thermo-Control Fan**—A 16-page booklet describes a fan for automatic precision temperature control of coolants in internal combustion engines. It is said to control the jacket water temperature of all types of internal combustion engines within closer limits than has been possible with previous methods.—*Evans Products Co., Detroit, Mich.*

Steel-framed Buildings—An illustrated, 24-page catalog describes and pictures nailable framing for light occupancy structures. It includes many examples of steel-framed buildings; joist loading and general properties tables, and isometric drawings of many construction details.—*Great Lakes Steel Corp., Stran-Steel Division, 3750 Penobscot Bldg., Detroit 26, Mich.*

Tractor Equipment—Designed to assist equipment owners and operators in the selection of proper tractor tools, a new 8-page folder tells about current models of carryall scrapers, tilt-dozers, rooters, cranes, and power control units. Many on-the-job photos show each type of equipment in different applications, which are accompanied by explanations of proved operating methods. *R. G. LeTourneau, Inc., Peoria, Ill.*

Protective Coatings—A booklet contains information on protective coatings.

POWERFULLY BUILT FOR POWERFUL WORK

MURPHY DIESELS have that heavy-duty "build" required to stand up under toughest continuous power service. They are rugged and powerful . . . simple and economical to operate and maintain. Compact, relatively light in weight, and dependable on a wide range of work. Easy to start in any temperature. They require no premium priced fuel. They have what it takes for "More Power, More Profit". Specify Murphy Diesels for new equipment, or to convert present machinery for improved performance and economy

MURPHY DIESEL *Outstanding Features:*

1. **MURPHY UNIT INJECTOR**
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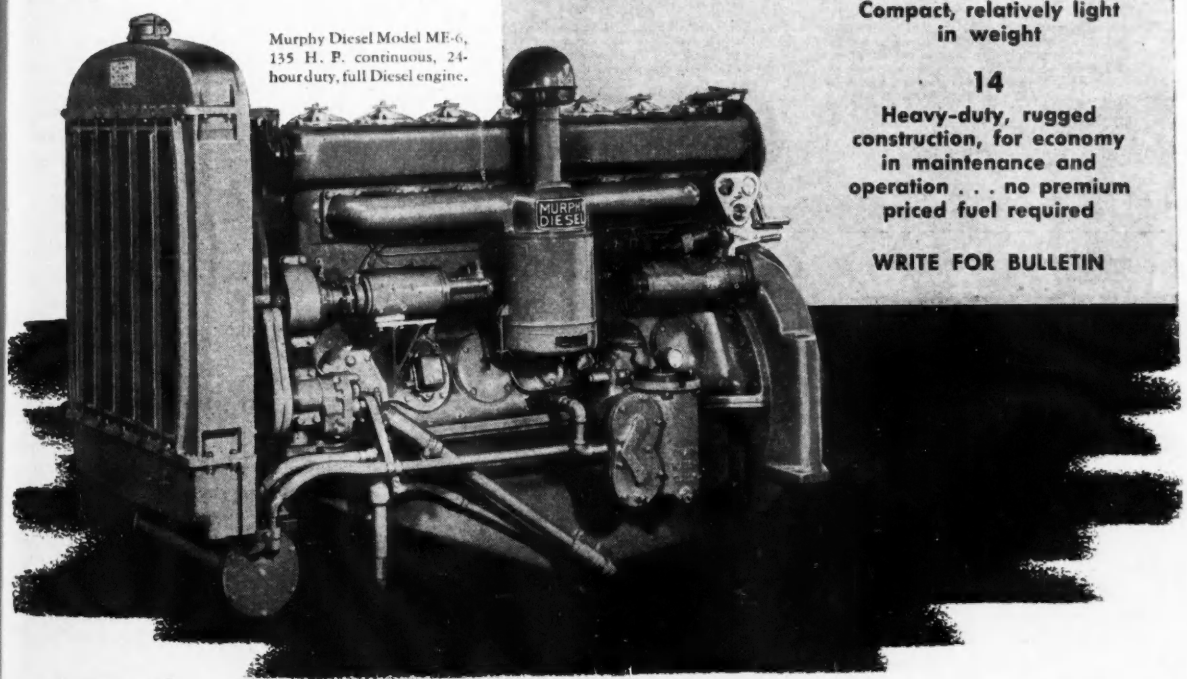

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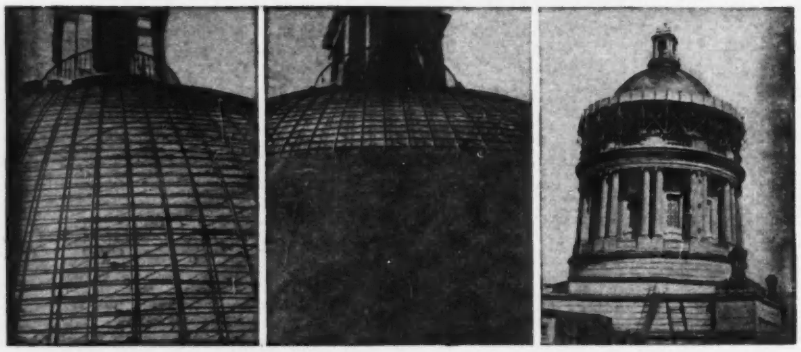

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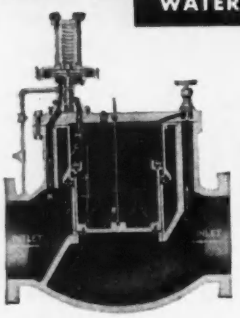

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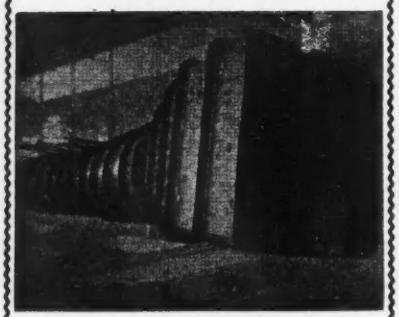

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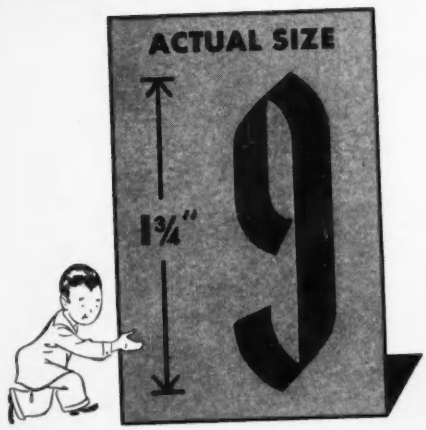

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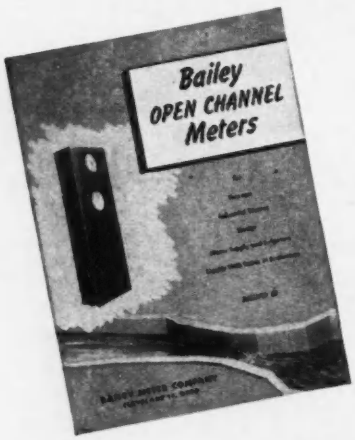

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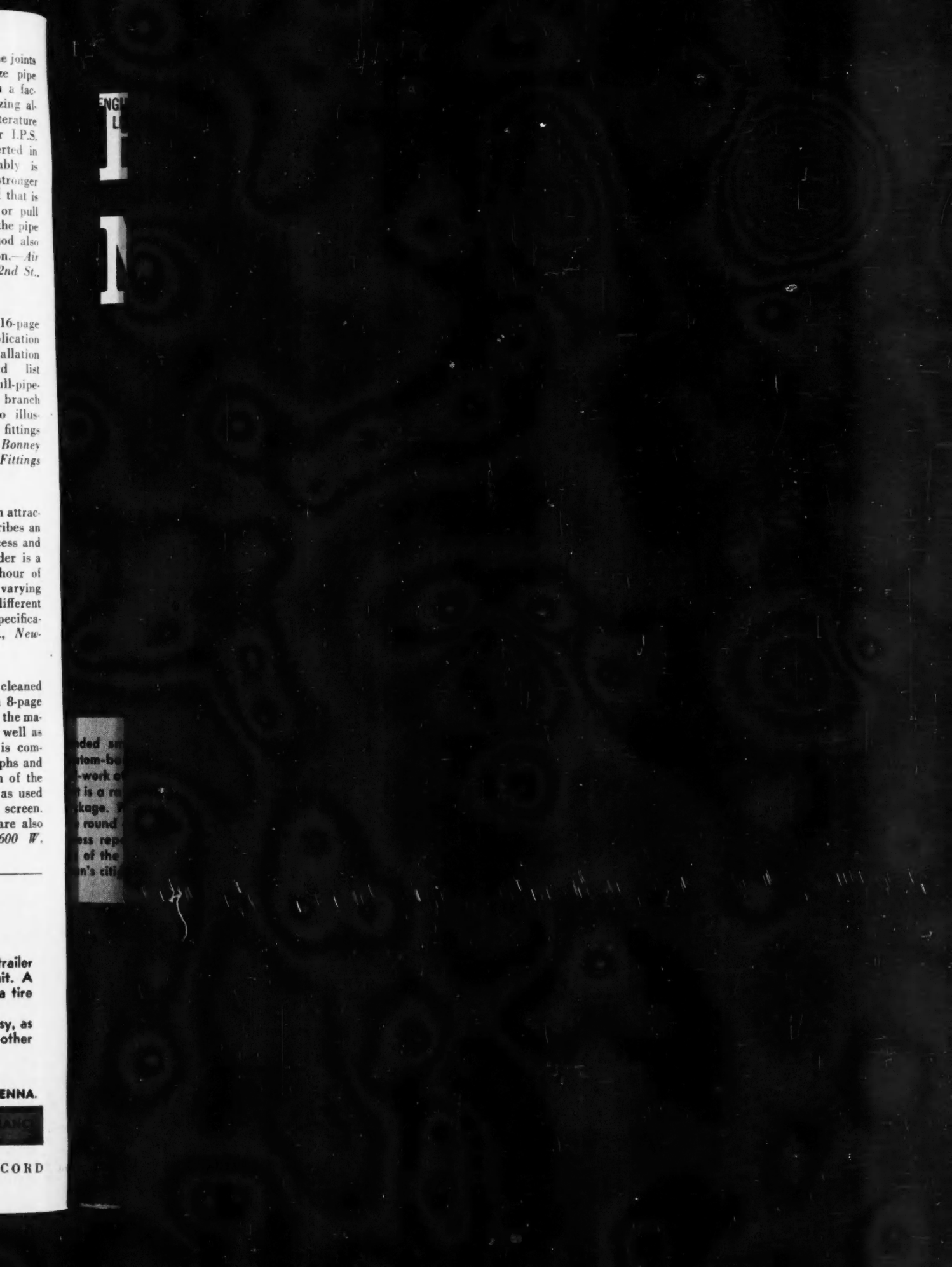
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